SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY 1912.

GENERAL PHYSICS.

1. *Change of Shape of Thin-walled* (*Bourdon*) *Tubes.* **T. v. Kármán.** (Zeitschr. Vereines Deutsch. Ing. 55. pp. 1889–1895, Nov. 11, 1911.)—The ordinary theory of bending, which neglects changes of cross-section, leads to great discrepancies between theory and fact in the case of tubes initially bent. The strains in the fibres will be as calculated only if they do not move relatively to the neutral axis. Actually this movement causes the strains to be much less: if a tube of 800 mm. diam. is flattened in cross-sectional diameter by 1 mm. the extreme stresses are reduced by 1250 kg./cm.^{2}. It is evident that a given amount of bending is caused by a much smaller moment than the ordinary theory supposes. A simple theory, and one which gives results in good accord with practice, is based on the theory of minimum work done in cross-sectional deformation. The work done in bending a rod or tube consists of two parts—one in lengthening the fibre considered, the other in moving the element towards or from the neutral axis. In a solid rod or a tube with thick walls the work done in altering the cross-section is considerable, so that the reduction in work done in longitudinal strain (produced by the charge) is compensated, and the ordinary theory is approximately correct. But in thin tubes the resistance to cross-sectional distortion is proportionately much less, and the total work is less than the ordinary theory assumes. The author proceeds to work out a theory on the assumption that the total cross-sectional strain is zero. He deduces an equation for the total work expended in bending the tube. This takes the form $M_b = x\theta E(1/R' - 1/R)$, where θ = moment of inertia of the section, E = modulus of the material, R′ and R are the new and old radii of curvature, and x is a constant for each tube. $x = 1 - 9/[10 + 12(\delta R/r^2)^2]$; here δ = thickness of tube, R = its radius of curvature, r = radius of cross-section. For spiral tubes the discrepancy between practice and theory is reduced from 800 per cent. to 20 per cent. by applying this corrected formula in place of the ordinary one. It is suggested finally that the use of the ordinary bending theory for Bourdon pressure-gauge tubes leads to serious mistakes. C. A. M. S.

2. *Influence of Oscillatory Discharge on Rapidity of Decay of Torsional Oscillations.* **E. Drago.** (Accad. Lincei, Atti, 20. pp. 369–376, Oct. 15, 1911.)—Continuing his work on this subject [Abstract No. 1428 (1911)] the author concludes that (1) the rapidity of decay of torsional oscillation of thin iron wire diminishes under the influence of an oscillatory discharge or an alternating current; (2) the production in the magnetising spiral of a series of oscillatory discharges at variable intervals of time increases the rate of decay of torsional oscillations, reaching a maximum when such excitations take place at the beginning and end of each simple vibration of the wire; (3) by increasing the frequency of these excitations, the acceleration of decay of torsional vibration is reduced until a critical point is reached, beyond which further increase of frequency of excitation diminishes the rate of decay of oscillation. (4) Electric waves increase the rate of decay, the max. effect being produced when the excitation is at the beginning and end of each simple vibration of the wire. W. H. Si.

3. *A Criterion for Best Magnitudes in Precise Measurement.* **M. D. Hersey.** (Washington Acad. Sci., Journ. 1. pp. 187–190, Nov. 4, 1911.)—In the determination of a quantity y from observations of the independent variables x_1, $x_2 \ldots x_n$, with which y is connected by the equation $y=f(x_1, x_2 \ldots x_n)$ we are frequently at liberty to choose the order of magnitude of the various x's before setting up the apparatus. The author obtains a mathematical criterion from which the best values to be assigned to these magnitudes can in many cases be readily determined. Particular cases of his general criterion give the best conditions (1) to secure a minimum absolute error; (2) to make the fractional error a minimum; (3) to make the absolute error a minimum when there is a constant error in x; and (4) to make the fractional error a minimum, the error in x being constant. The theory is illustrated by numerical examples. A. R.

4. *Gravity Determinations at Sea.* **O. Hecker.** (Amer. Journ. Sci. 32. pp. 388–398, Nov., 1911.)—The author criticises certain points in L. A. Bauer's recent paper on this subject [see Abstract No. 812 (1911)]. He explains that several corrections made to the readings in his own researches, which Bauer implied had not been used, were in fact used. Hecker's method, too, of making adjustments did not result in the average gravity anomaly on a cruise being theoretically zero as Bauer states, and, moreover, the figure referred to by Bauer was obtained by combining, not all the observations, but only those where the bottom of the sea was of uniform depth and where no important anomalies of gravity were to be expected. A. D. R.

5. *Relativity Principle and the Ether.* **E. Wiechert.** (Phys. Zeitschr. 12. pp. 689–707, Sept. 1, and pp. 737–758, Sept. 15, 1911.)—Whereas many have held that the acceptance of the relativity principle involves abandonment of the conception of the ether, it is here contended that the relativity principle, so far from contradicting the hypothesis of the ether, brings very important new evidences for the existence of the ether. [See Abstract No. 810 (1910).] E. H. B.

6. *Permeability of Porcelain and Copper Ferrocyanide Membranes.* **F. E. Bartell.** (Journ. Phys. Chem. 15. pp. 659–674, Oct., 1911.)—Poiseuille's laws for the passage of liquids through capillary tubes are shown to apply to the

passage of water through unglazed porcelain from pressures of 58 mm. of mercury to pressures of 5885·7 mm. Poiseuille's laws were also found to apply to the effects produced by changes of temperature from 22·8° to 70° C. The same laws were also found to apply to the flow of water through membranes of copper ferrocyanide precipitated electrolytically. T. M. L.

7. *Origin of the Permanent Ocean Highs.* **W. J. Humphreys.** (Mount Weather Observatory, Bull. 4. pp. 1–22, 1911.)—Examining the local physical conditions in the regions bounding the five permanent ocean highs, it is concluded that these localised maxima of high pressure are the result of mechanical and thermal circulation, *i.e.*, each is a little west of the intersection of the coldest portion of an ocean current with a high-pressure belt. Other portions of the paper deal with the origin of corresponding regions of cyclonic low pressure associated with warm currents, vertical temperature gradients, and levels of maximum and minimum cloudiness. C. P. B.

8. *The Upper Trade-winds.* **W. van Bemmelen.** (Nature, 87. p. 415, Sept. 28, 1911.)—Peppler has pointed out that the pressure gradient from the equator towards the sub-tropical zones is positive at the heights of the anti-trade-winds, but negative higher up (20 km.). Above the anti-trade there should hence be an upper trade-wind blowing towards the equator. Comparing the barometric records obtained during the balloon ascents from the *Otario* in the North Atlantic (30° N. Lat.) with those observed at Batavia (6° S. Lat.), the author finds at Batavia air pressures of 164, 100, 86, 74, 63 mm. at 12, 15, 16, 17, 18 km., while the records from the N. Atlantic were 157, 99, 85, 74, 65 mm. at the same heights. There is hence a reversal after the 17-km. level is exceeded. Numerous balloon observations at Batavia, moreover, show that the anti-trade reaches its max. strength at from 12 to 15 km. (higher in the rainy season), and that feeble southerly or westerly winds blow higher up. A pilot balloon of 2 kg. reached 22 km., and the wind velocity rose fairly regularly from 12·8 m./sec. at 13 km. to 26·9 m. at 16·5 km., (anti-trade), dropped to 7·5 and 4·6 m. at 17 and 17·5 km., and rose steadily again to 30·8 m. at 22 km. (upper trade-wind). H. B.

9. *Ammonia in Antarctic Snow and Rain.* **A. Müntz and E. Lainé.** (Comptes Rendus, 153. pp. 749–750, Oct. 23, 1911.)—During the Charcot expedition Godfroy took 4 samples of rain and 14 of snow. The authors subsequently found about 0·42 mgm. of ammonia per litre in the snow (max. 1·5 mgm.) and 0·89 mgm. in the rain; there was, however, one rain sample with 9·82 mgm. of ammonia per litre; but such abnormal cases have been observed in Europe. On the whole the ammonia-content of the snow and rain in Antarctic latitudes seems to be the same as in Europe. H. B.

10. *Rigidity of the Earth.* **J. Prescott.** (Phil. Mag. 22. pp. 481–505, Oct., 1911.)—The paper deals with the analysis of the necessary calculations on the yielding of elastic spheres for the purpose of comparison with observations of pendulum deflections, with the object of finding therefrom the average rigidity of the earth. All previous work in this direction has been for spheres of uniform density, but this paper assumes a variation of density as near the actual distribution as can be inferred from present knowledge. The lunar deviation is much more reliable for coupling up than the solar deviation, on account of the disturbing effect of temperature on the earth's

surface. The general result from a discussion of tidal observations is that the rigidity of the earth is about half that of wrought iron. On the other hand, discussion of the ellipticity leads to the conclusion that the earth is much more rigid than steel. C. P. B.

11. *Vertical Component of Seismic Vibration.* **B. Galitzin.** (Acad. Sci. St. Pétersbourg, Bull. 14. pp. 988–1006, Oct. 15, 1911.)—The author discusses the observations made with his vertical-component seismograph in the earthquake observatory at Pulkowa. The initial displacement in the record given by the arrival of the first wave of the preliminary tremors shows whether we are dealing with a condensational or dilatational wave: the former are about twice as common as the latter. The observations also show that the ratio of the max. vertical displacement to the corresponding horizontal displacement in the large waves of a distant earthquake is always smaller than its theoretical value of 1·47. The paper concludes with a mathematical discussion of the determination of the angle of emergence of first-phase seismic radiations. A. D. R.

12. *Second-phase Seismic Waves.* **B. Galitzin.** (Acad. Sci. St. Pétersbourg, Bull. 14. pp. 1019–1028, Oct. 15, 1911.)—A theoretical discussion of the method of determining the direction of vibration of a point on the earth's surface in the transverse second-phase preliminary tremors of an earthquake. The necessary observations are obtained from Galitzin horizontal and vertical seismographs, and several examples of the application of the method are given. A. D. R.

13. *Solar Prominence of October* 10, 1910. **F. Slocum.** (Astrophys. Journ. 34. pp. 294–298, Nov., 1911.)—Excellent reproductions are given and described of an interesting solar prominence photographed with the Rumford spectroheliograph on Oct. 10, 1910. The photographs were obtained in calcium (H) light, and are compared with others taken at Mount Wilson with hydrogen ($H\alpha$) light. C. P. B.

14. *Absorption Markings in* $H\alpha$ *Spectroheliograms.* **T. Royds.** (Roy. Astronom. Soc., M.N. 71. pp. 723–725, 1911.)—$H\alpha$ spectroheliograms have been taken almost daily at Kodaikanal since April, 1911. These show the dark markings already noticed by Hale, Deslandres, and others, which are supposed to indicate prominences causing additional absorption. It has been found that the best results are obtained when the camera slit is set on the violet side of the centre of the $H\alpha$ line, the displacement being about 0·2 Å. When the camera slit is displaced towards the red side of the line the absorption markings disappear, the entire surface becoming covered with a coarse network of dark markings. Measurements of the speed of rotation give an apparent sidereal angular motion of 14·8° per day, which is considerably greater than that of sun-spots. This could be accounted for by assuming that the absorption is localised some 80″ above the solar photospheric surface. C. P. B.

15. *Sun's Energy-spectrum and Temperature.* **C. G. Abbot.** (Astrophys. Journ. 34. pp. 197–208, Oct., 1911.)—Spectrobolometric observations, extending over the period 1908–1910, at Washington, Mount Wilson, and Mount Whitney, made with various optical systems, including flint glass, ultra-violet crown glass, and quartz prisms, with mirrors of silvered glass, magnalium, &c.,

have been used to determine the distribution of energy in the solar spectrum outside the atmosphere. The results appear to depend more on the spectroscope employed than on the altitude of the observing station. For the adopted mean normal spectrum-energy curve the maximum of energy falls at wave-length 0·470 μ. Intensities at other wave-lengths are detailed in a table, as are also the mean coefficients of atmospheric transmission for vertical rays. Attention is drawn to possible departures of the solar radiation from that of the perfect "black body." The probable value of the solar temperature taken as a perfect radiator is about 6000° C. (abs.); but allowing for the divergence from perfect radiation, the temperature would be about 7000° C. (abs.). C. P. B.

16. *Intensity Scale for Solar Spectrum Lines.* **F. W. Very.** (Science, 34. pp. 528–529, Oct. 20, 1911. Paper read before the Astronom. and Astrophys. Soc. of America.)—In the search after a definite system of registration of spectrum line intensities, Rowland's intensities of the solar spectrum lines have been compared with the true photometric intensities of ultra-violet lines on negatives by Higgs, and the resulting comparisons are tabulated. It is shown that, in general, the relation between the width and the intensity of the photographic images of spectral lines is not so simple as has been assumed. It is also shown that differences of width of spectral lines have been exaggerated in Thollon's atlas. C. P. B.

17. *Rotation of the Sun.* **J. S. Plaskett.** (Science, 34. p. 580, Oct. 20, 1911. Paper read before the Astronom. and Astrophys. Soc. of America.)—The mean of 28 plates taken with the new spectrograph at the Ottawa Observatory, gives an equatorial velocity of 2·084 km. per sec. In the region λ5000–5700, the measures of 50 spectra furnish no evidence that this velocity due to any particular element differs from that of the reversing layer. C. P. B.

18. *Determination of Planetary Positions.* **R. T. A. Innes.** (South African Journ. Sci. pp. 327–330, June, 1911.)—A discussion is given of what might have to be the system of time-keeping if the earth were not rotating, the suggested methods depending on the eclipses of Jupiter's satellites, motions of satellites of Saturn, variations of variable stars, &c. Turner's method of determining star-places by rectangular co-ordinates on photographic plates is supported. C. P. B.

19. *Formation of Suns.* **C. André.** (Comptes Rendus, 153. pp. 792–795, Oct. 30, 1911.)—An outline is given of the modification of Laplace's hypothesis of the formation of suns by the contraction of a primordial nebula, in which the existing bodies are divided into two series, one set nebulous and of increasing temperature, the other stellar and of descending temperature. C. P. B.

20. *Spectrum of Comet Brooks* (1911*c*). **J. Bosler.** (Comptes Rendus, 153. pp. 756–757, Oct. 23, 1911.)—Photographs of the comet spectrum were obtained with a prismatic reflector on Lumière Σ and Wratten Verichrome plates. Three plates had exposures of 25, 60, and 95 min. respectively, the spectrum of Vega (α Lyræ) being used as comparison. In the spectrum of the nucleus all the hydrocarbon series of bands are shown, λλ612, 560, 516, 473. Other bands are shown at λλ4865, 431, 421, 388. The photograph taken on

Sept. 25 with an exposure of 95 min. shows the tail spectrum very clearly, the radiation λ401 extending quite 1° 30′ from the nucleus. **Iniguez.** (Ibid. pp. 757–758, Oct. 23, 1911.)—Description of photographs of the comet and its spectrum as obtained at the Madrid Observatory. In the spectrum 7 condensations are shown, with a feeble continuous radiation. The first part of the tail is shown feebly in the radiations λλ555, 514, 472. **J. P. Lagrula** and **H. Chrétien.** (Ibid. pp. 926–927, Nov. 13, 1911.)—Observations made at the Nice Observatory on Oct. 29 and 30, with the same instruments as before described [Abstract No. 1448 (1911)] showed a globular nucleus very sharply defined, about 20′′ diam., and a tail composed of numerous filaments. The spectrum photographed shows great similarity to that of Comet Daniel (1907*d*): a continuous spectrum on which was superposed the bands of cyanogen and carbon. The tail bands are the well-known doublets now recognised as produced by CO at low pressures. **J. Bělopolsky.** (Astronom. Nachr. No. 4535. Nature, 88. p. 121, Nov. 23, 1911. Abstract.)—Several photographs of the spectrum of the comet were obtained at Pulkowa with both slit and objective-prism spectrographs. Bands were shown at λλ560, 516, 473, 405, and 388. C. P. B.

21. *Radial Velocity of αCygni.* **O. J. Lee.** (Astrophys. Journ. 34. pp. 303–307, Nov., 1911.)—Neuimin and Bélopolsky have recently announced the detection of residuals when the velocities derived from the H and He lines were compared with those obtained from the metallic lines. To obtain evidence on this point a set of plates taken at the Yerkes Observatory with the one-prism spectrograph have been specially measured, and the conclusion is that they do not confirm the result announced by the Russian observers; the discrepancy found may be due to the complexity of the hydrogen line structure. C. P. B.

22. *Visual Binary Stars.* **H. N. Russell.** (Science, 34. pp. 523–525, Oct. 20, 1911. Paper read before the Astronom. and Astrophys. Soc. of America.)—Applying the analytical method for expressing the relation between the density and surface brightness of binary stars, it is found that the whiter stars are very much brighter for equal masses than the red stars, while the stars of any one spectral type are much more similar in brightness. Other details are given of the relative brightnesses of the star groups designated by Hertzsprung "giant" and "dwarf" stars. C. P. B.

23. *Wave-lengths of Silicon Lines in Stellar and Laboratory Spectra.* **S. Albrecht.** (Science, 34. pp. 533–534, Oct. 20, 1911. Paper read before the Astronom. and Astrophys. Soc. of America.)—Attention is drawn to the varying wave-lengths given by different observers to the Si lines near λ4552·7, 4567·9, 4574·9, as seen in stellar and laboratory spectra. As they are so important in the study of celestial spectra, their wave-lengths should be more rigidly determined. C. P. B.

24. *Fundamental Systems of Stellar Wave-lengths.* **S. Albrecht.** (Science, 34. p. 534, Oct. 20, 1911. Paper read before the Astronom. and Astrophys. Soc. of America.)—The object of the paper is to eliminate systematic errors in the wave-lengths of the lines in the spectra of B type stars. In the types A–M sufficient continuity is shown in the origins of the spectrum lines to allow of satisfactory identification of the lines from class to class. With a few exceptions, however, the lines of B type stars are quite different from most other stars. For instance, taking the hydrogen line Hγ, its wave-length in A type stars is 4340·655, and it diminishes progressively from types A to G, and more rapidly from K to M. Extending this relation to the B type, the computed wave-length would be 4340·657, whereas it is observed to be 4340·627. An accurate knowledge of the behaviour of spectrum lines under various different conditions is therefore advisable. C. P. B.

25. *Bode's Law and Spiral Structure in Nebulæ.* **W. Sutherland.** (Astrophys. Journ. 34. pp. 251–280, Oct., 1911.)—Evaluating the analytical form of the Bode's law formula, the similarity to the equation of a simple logarithmic spiral is suggested, indicating the possibility that the solar system in its evolution has passed through the stage of a spiral nebula. Measurements made on photographs of spiral nebulæ by Ritchey and Roberts are discussed, showing that the curves are very sensibly those of logarithmic spirals. To verify the theory, observations are wanted of inward motion along spirals, and the demonstration of a process of segmentation of the spirals. C. P. B.

26. *Electric Chronometer.* **C. Féry.** (Journ. de Physique, 1. Ser. 5. pp. 815–820, Oct., 1911. Paper read before the Soc. Franç. de Physique, April 7, 1911.)—Description of a design for electric chronometer movement, with a special adjustment for temperature control. Tables are given, showing the rates observed over periods of about twelve days. C. P. B.

27. *Plasticity of Ice.* **H. Hess.** (Ann. d. Physik, 36. 3. pp. 449–492, Nov. 9, 1911.)—A large hydraulic press was used in the research, the results of which are tabulated and the conclusions applied to glacier motion. [See also Abstract No. 1989 (1902).] A. W.

28. *Relativity Mechanics of Deformable Bodies.* **G. Nordström.** (Phys. Zeitschr. 12. pp. 854–857, Oct. 15, 1911.)—The development of hydrodynamics on the relativity principle. [See Abstracts Nos. 2128 (1909), and 1197, 1215, and 1341 (1910).] E. H. B.

29. *Mechanics of Deformable Bodies on the Relativity Theory.* **G. Herglotz.** (Ann. d. Physik, 36. 3. pp. 493–533, Nov. 9, 1911.)—A treatment based on the assumption that for the motion of the body a kinetic potential exists which is invariant for the Lorentz transformation, and for rest reduces to a given function of the deformations and of the entropy of separate volume-elements. [See Abstracts Nos. 1480 (1907) and 1086 (1911).] E. H. B.

LIGHT.

30. *Auto-collimating Spectroheliograph at Kodaikanal.* **J. Evershed.** (Roy. Astronom. Soc., M.N. 71. pp. 719–728, 1911.)—The routine spectroheliograph at Kodaikanal is admirably adapted for working on lines in the violet region of the spectroheliograph, but is of too small dispersion for investigation in the red. To provide for work on the H*α* line a new auto-collimating spectroheliograph has been constructed, with a Michelson plane diffraction grating as the dispersion piece. The combined collimator and camera lens is 4¼ in. diameter and 8 ft. focal length. Both camera and collimator slits are fixed in width at 0·06 mm., it being found unnecessary to have them adjustable, and greater simplicity is of advantage in this work. C. P. B.

31. *Dispersion and Measurement of Concave-grating Spectrograms.* **F. Goos.** (Zeitschr. wiss. Phot. 10. pp. 200–208, Nov., 1911.)—The author's results, in international units, obtained with a Rowland plane grating, for the third-order iron spectrum, showed in places systematic differences from the recently-published concave-grating measurements of Kayser [Abstract No. 69 (1911)], which seemed to indicate that the conditions required by theory for extreme accuracy had not been attained in practice. A discussion is given of the differences, from which it appears that it is doubtful, with concave-grating spectrograms, whether it is permissible to interpolate linearly, even for narrow intervals, without applying corrections, since we do not know beforehand in what range of the plate the constancy of the quantity $ds/d\lambda$ is sufficient. It is therefore better to traverse larger distances, using a long measuring-screw, since only then is it possible to ascertain corrections and to obtain results free from objections. A. W.

32. *Propagation of Light in Fluorescent Substances.* **J. Becquerel.** (Comptes Rendus, 153. pp. 986–988, Nov. 13, 1911.)—The problem discussed is the following: Can the fluorescence of a substance modify its absorbing power for the radiations of the same period as the radiations emitted? Various investigators have dealt with the subject, some obtaining positive, others negative results [see Abstracts Nos. 2554 (1904), 1002, 1573, 1866 (1905), 287 (1911)]. Experiments with plates of emerald and ruby about 2 mm. thick show that the fluorescent state does not sensibly alter the velocity of propagation of radiations of the same period as the radiations emitted. It appears probable that the "absorption of fluorescence" does not exist. A. W.

33. *Optical Temperature Coefficients of Rock-salt, Sylvin, and Fluorite.* **E. Liebreich.** (Deutsch. Phys. Gesell., Verh. 13. 19. pp. 700–712, Oct. 15, 1911.)—A continuation of the author's work on the variation of refractive index with temperature in the infra-red region for rock-salt, sylvin, and fluorite [Abstract No. 608 (1911)]. The work has been extended to still lower temperatures. The temperature of the prism used was measured by means of an iron-constantan thermo-element. The minimum temperatures reached were for fluorite, about 52 deg. C., for sylvin about 50 deg. C., and for rock-salt about 46 deg. C. below the room temperature (18° C.). The results of the experiments establish the fact that the absolute values of the temperature coefficients are

smaller with decreased temperature. The temperature coefficient of rock-salt reaches a minimum between 1 and 1·25 μ, that of sylvin between 2 and 3 μ, and that of fluorite between 0·8 and 0·9 μ. A. W.

34. *Radiation Phenomena.* **A. Joffé.** (Ann. d. Physik, 36. 3. pp. 534–552, Nov. 9, 1911. Paper read before the Russian Physical Soc., Sept. 27, 1910.)—A theoretical discussion on a broader basis than the works of W. Wien and of M. Planck, which are confined to black radiation. The chief conclusions arrived at are as follows: (1) The experimental facts of photo-electricity, photo-chemistry, light ionisation, fluorescence, and phosphorescence may be explained by the properties of radiation if we measure the efficacy of the light directly by the frequency and not by the black temperature. (2) The evaluation of a reversible cycle with monochromatic light shows indeed that the power of the light to do work is measured by the frequency ν. The expression for the radiation energy transferred to a system is written $dL = \nu dW$, where ν appears as an intensity factor and W as a new function of the condition of the radiator. (3) The quantities ν and W are generalised for the case of mixed radiation, and a mean value $\bar{\nu}$ is introduced. 4) The energy of a radiation quantum is proportional to $\bar{\nu}$. (5) The analogy is sketched between radiation and an ideal gas, and the most probable partition of energy is discussed. E. H. B.

35. *Reversal and Re-reversal.* **J. Sterry.** (Photographic Journ. 51. pp. 320–322, Oct., 1911.)—The study of effects of excessive exposures (greatly in excess of those required for ordinary work) is of great interest from a theoretical standpoint, and may be expected to throw a considerable amount of light upon the nature of the latent image. The paper used in these experiments is the Ilford Plat. Matt. The exposure is 40 seconds sunshine, and the developer used is 1 part rodinal in 100 of water. The illustration given is arranged so as to cover the whole of the ground considered, from the normal negative image to the period of re-reversal. From this illustration it appears that from the lowest exposure there is a constant increase of density up to the first critical point—a zone which represents the period of correct and over-exposure in ordinary negative work. From the first to the second critical point is the period of reversal, giving a positive, while from the second critical point to the greatest exposure a second negative is obtained. This is the period of re-reversal. The behaviour during development is considered. It would seem that reversal cannot be considered to be a simple periodic change due to the action of light, but rather as due to secondary actions, and though a fixed point under similar conditions, is readily shifted in many ways. Re-reversal, so far as that which cannot be developed is concerned, appears to be due to the action of light giving a visible image without development. A. E. G.

36. *Light and Development.* **J. Sterry.** (Photographic Journ. 51. pp. 322–328; Discussion, pp. 328–330, Oct., 1911.)—The reduction of silver obtained by the development of various exposures whilst in the first place due to the action of light, does not of necessity indicate the relative amounts of light action upon the silver compound. To obtain a true measurement of the action of light alone, it is evident that similar or proportional results should be obtained with any developing agent. Up to the present, only 3 points in the characteristic curve of light and development action can be said in any wise to fulfil this condition and to be approximately true measurements of the action of light alone. These are the point of first appearance of reduction, and the first and second critical points of reversal and re-reversal. The general results of the action of light, of sodium thiosulphate and of developers, the inertia, y_∞, the latitude, the action of weak oxidisers, the physical development after fixing, and the best methods of obtaining the primary latent image, the secondary latent image, and the print-out image, are given in tabular form. A. E. G.

37. *Influence of Neutral Gases on the Absorption of Na-vapour.* **K. Fredenhagen.** (Phys. Zeitschr. 12. pp. 909–911, Nov. 1, 1911.)—Describes further research on the absorption of Na-vapour, from which it is concluded that the number of absorbing particles in Na-vapour is increased by the admission of neutral gases to the absorption tube. The author has previously shown that the presence of neutral gases considerably increases the tendency to form ions in Na-vapour; hence it follows that there must be a connection between the conditions which affect ionisation and absorption. [See Abstracts Nos. 1878 (1906), 1848 (1907), 1815 (1910), 657, 1485 (1911).]

A. W.

38. *Absorption of Light by Inorganic Salts I.–IV.* I. *Aqueous Solutions of Cobalt Salts in the Infra-red.* **R. A. Houstoun.** (Roy. Soc. Edinburgh, Proc. 81. pp. 521–529, 1910–1911.)—The values of the constant A in the equation $I = I_0 10^{-Acd}$ (c = concentration in gm.-mols. per litre, d = thickness of solution) were determined for a number of cobalt salts, for a series of wavelengths in the infra-red from $\lambda = 0{\cdot}684$ to $18{\cdot}8\,\mu$. A minimum value was usually observed at about $\lambda = 0{\cdot}750\,\mu$. Stronger solutions showed also a max. absorption at $\lambda = 1{\cdot}8\,\mu$, whilst two samples of cobalt glass gave a max. absorption at $1{\cdot}15\,\mu$; the general effect of increasing the concentration is to increase the absorption at the ends of the region investigated without greatly increasing the smaller absorptive power in the middle region. Heating the solutions was found to have the same effect as increasing the concentration. II. *Aqueous Solutions of Cobalt Salts in the Visible Spectrum.* **R. A. Houstoun** and **A. R. Brown.** (Roy. Soc. Edinburgh, Proc. 81. pp. 530–537, 1910–1911.)—In this paper the absorption-coefficients are given for 5 cobalt salts from $\lambda 434\,\mu\mu$ to $717\,\mu\mu$. A max. absorption was usually observed about $\lambda 500\,\mu\mu$. Increasing the temperature increased the absorption in this region in the case of the sulphate, nitrate, iodide, and bromide, but in the case of the chloride raising the temperature to 80° caused the development of a band, at $\lambda 650\,\mu\mu$, far stronger than the original one at $500\,\mu\mu$. This second band could be detected in cold concentrated solutions, but not in the cold dilute solutions, and was also developed in hot solutions of the bromide. III. *Aqueous Solutions of Nickel Salts in the Visible Spectrum and the Infra-red.* **R. A. Houstoun.** (Roy. Soc. Edinburgh, Proc. 81. pp. 538–546, 1910–1911.)—Curves are given for the absorption coefficients of six nickel salts from $\lambda = 0{\cdot}434\,\mu$ to $1{\cdot}27\,\mu$. The curves show a very strong maximum or band on the borders of the ultra-violet at about $0{\cdot}4\,\mu$ with weaker bands at $0{\cdot}7\,\mu$ on the border of the infra-red and at $1{\cdot}2\,\mu$; between these bands the absorption becomes very slight, except in the case of the iodide, which shows a marked absorption throughout the visible region. IV. *Aqueous Solutions of Cobalt and Nickel Salts in the Ultra-violet.* **R. A. Houstoun** and **J. S. Anderson.** (Roy. Soc. Edinburgh, Proc. 81. pp. 547–558, 1910–1911.)—An ingenious method of ultra-violet photometry was devised in which the upper and lower parts of a slit were illuminated by two ground quartz plates placed at unequal

distances from an iron arc and therefore unequally illuminated according to the law of inverse squares. The brighter plate was used as a source for the light passing through an absorptive solution, whilst the light from the less brightly illuminated plate passed through water only. By moving one of the plates along a series of 11 standard positions a match could be obtained for 11 different percentage absorptions: by noticing the wave-lengths at which the matching occurred it was possible to obtain a series of points on the curves in which the absorption-coefficients A are plotted against wave-length λ. The chief nickel band at wave-length 500 μμ, lying in the visible region is paralleled by a cobalt band at 400 μμ on the extreme limit of visibility. Beyond this point the sulphates of Ni and Co show no marked absorption, but the nitrates give a very intense absorption at 300 μμ, followed by a minimum at 270 μμ and an even more intense absorption beyond: as the curves for the two nitrates are practically identical in the ultra-violet region and differ entirely from those for the sulphates, it would appear that the intense ultra-violet absorption depends on the nitrate-radical rather than on the metal. In the same way the iodides give absorption bands at 300 μμ and 350 μμ, which are identical with the bands for free iodine and increase in intensity when the salts are kept. T. M. L.

39. *Absorption Spectra of Complex Inorganic Salts.* **E. Valla.** (Accad. Lincei, Atti, 20. pp. 406–411, Oct. 15, 1911.)—As a preliminary note, the coefficients of extinction and absorption between λ = 6060 and λ = 4607, are given for aqueous solutions of $[Co(NH_3)_4CO_3]Cl$, $[Co(NH_3)_4(OH_2)_2]Cl_3$, $[CO(NH_3)_5(OH_2)]Cl_3$, $[Co(NH_3)_3(NO_2)_3]$, $[Co(NH_3)_4NO_2.Cl]Cl$, $[Co(NH_3)_5Cl]Cl_2$, $[Co(NH_3)_5NO_3](NO_3)_2$, and $[Co(NH_3)_2(NO_2)_4]K$, the strengths of solution ranging from N/32 to N/256. The absorption spectra of the salts are very different, and the coefficient of absorption varies with the concentration. With all the salts except the last, the max. absorption occurs between about λ = 5100 and λ = 5000 for all dilutions. W. H. St.

40. *Study of Beer's Law for Absorption in the Infra-red Spectrum.* **F. Lindholm.** (Ark. för Mat. Astron. och Fysik, Stockholm, 7. Nos. 1–2, pp. 1–12, 1911.)—The infra-red absorption spectrum of benzene, which is characterised especially by well-marked bands situated at wave-lengths 1·7, 2·7, and 3·4 μ, has been studied by means of measurements with the spectrobolometer. The object of the investigation was to determine whether dilution modifies the absorption when the number of absorbing molecules remains constant. Carbon disulphide and carbon tetrachloride were used as solvents for the benzene, the concentrations of the solutions in these two solvents varying from 22·5 to 100 per cent., and 1·68 to 100 per cent. respectively. The records given by the bolometer were identical in all cases, and measurements of the energy at the various absorption maxima showed that there was no quantitative change in the absorption in the different solutions; it follows that Beer's law holds for the liquid mixtures investigated. It was also shown that the position of the absorption bands remains invariable, and independent of the nature of the solvent. T. S. P.

41. *Band Spectrum of Silicon Tetrafluoride.* **C. Porlezza.** (Accad. Lincei, Atti, 20. pp. 486–490, Nov. 5, 1911.)—The wave-lengths and intensities are given of 60 lines in the band spectrum of SiF_4, between λ = 5475·61 and λ = 3870·75, measured with the same grating as was employed by the author for his observations on hydrogen [Abstracts Nos. 1181 and 1484 (1911)]. By increasing the intensity of the discharge, by means of condensers, decomposition of the compound takes place, and the band spectrum is weakened, a brilliant line spectrum appearing which contains the lines of Si and F.

W. H. St.

42. *Resonance Spectra of Iodine Vapour and their Destruction by Gases of the He Group.* **R. W. Wood.** (Phil. Mag. **22.** pp. 469-481, Oct., 1911.)—A further study of the resonance spectra, and the effect of the other gases of the He group, as well as the remarkable polarisation of the light emitted by the vapour when stimulated by monochromatic radiations and white light [see Abstract No. 470 (1911)]. A number of improvements have been made in the arrangement of the apparatus, and it is now possible to show the resonance spectrum to a class by means of a commercial Cooper-Hewitt lamp (in glass) and a small pocket spectroscope. A glass tube 2 or 8 cm. in diam. and 80 cm. long is used. One end is blown out into a small bulb of diam. only slightly larger than that of the tube, care being taken to get the glass as free from striæ as possible. After drying, and after the introduction of a few small crystals of iodine, the tube is drawn down to a thick-walled capillary at the other end, highly exhausted and sealed. It is then mounted almost in contact with the lamp, and on looking down the axis of the tube through the bulb the yellowish fluorescent light is seen, which a spectroscope splits up into the bright-line resonance spectrum. In the present research such tubes were used in preference to the bulbs used in the earlier work; they were strongly illuminated by light condensed from two quartz mercury lamps about 12 cm. in length. The green line and both of the yellow lines of Hg are capable of exciting resonance spectra which can be exhibited separately. If a glass cell containing a strong solution of eosin is interposed between the arc and the iodine tube, the resonance spectrum excited by the two yellow lines appears: this consists of a beautiful series of equidistant doublets, 15 in all, 2 below and 12 above the yellow exciting lines. The yellow light can be removed from the exciting radiations by means of a saturated solution of neodymium chloride, and thus the series excited by the green Hg line is obtained. Photographs of the spectra obtained in this way are given. The series excited by the green Hg line, a set of 18 equidistant lines, is particularly striking, and shows a strong resemblance in character to the resonance spectrum of Na-vapour excited by the Cd line 4800. It had previously been shown that the introduction of He into the tube transformed the resonance spectrum, as the He pressure increased, into the band spectrum. The other gases of the group were now used. In He, at a pressure of 10 mm., the band spectrum is very strong and there is scarcely a trace of the resonance spectrum. In Ne at the same pressure the resonance spectrum is relatively much stronger. This is partially in accord with the views expressed by Franck and Wood, regarding the relation between the affinity of a gas for electrons and its action in destroying fluorescence. In Ar, Kr, and Xe a considerable reduction in the total intensity of the emitted light is found, and progressively less and less of the band spectrum is shown, Xe not giving a trace of the band spectrum. Further work in this direction is needed. As regards polarisation of the light of fluorescent gases, it is now found possible to obtain almost as strong polarisation with iodine vapour as was formerly [Abstract No. 1427 (1908)] observed with sodium. It was established that when the fluorescence was excited by polarised monochromatic light, the light was polarised in all of the lines of the resonance spectrum. The addition of He appears to diminish the percentage of polarisation, for in the bulb containing He at a pressure of 10 mm., the percentage of polarisation was found to be only 13, against 17 when the iodine vapour was *in vacuo*. In He at 10 mm. the resonance spectrum is completely replaced by the band spectrum, and the fact that polarisation is still present indicates that the polarised vibration is passed over to the other electron systems. A preliminary study of the appearance of resonance spectra under high resolving power was made, but no definite results were obtained.

A. W.

43. *Absorption Spectrum of Selenium Vapour.* **E. J. Evans** and **G. N. Antonoff.** (Astrophys. Journ. 34. pp. 277–287, Nov., 1911.)—As determined by Gernez, selenium vapour below 700° C. gives complete absorption except in the red. Above 700° C. absorption bands corresponding to bands in the emission spectrum make their appearance. [Abstract No. 1711 (1910).] For the present experiments the Se was placed in a quartz tube carefully evacuated after being filled with hydrogen. The tube could be heated to any required temperature by a suitable electric furnace. If the pressure is low, and the temperature of the Se-vapour kept constant at 600° C., absorption bands appear between λ3200 and λ3880. As the pressure increases there is complete absorption in this region, and bands appear more towards the red end of the spectrum. The ultra-violet bands diminish in intensity with increase of temperature.

C. P. B.

44. *Residual Rays of Selenite.* **H. M. Randall.** (Astrophys. Journ. 34. pp. 308–311, Nov., 1911.)—Recent determinations of the residual rays of selenite have been published by J. Koch [Abstract No. 1621 (1908)], determined by an interferential method and direct comparison with the sodium line. The present paper deals with an inquiry as to the constancy of result with various methods of determination, with the object of finding whether these residual rays may be employed as standards of wave-length in the infra-red region of the spectrum. To do this, energy curves of the radiation have been obtained with both grating and prism spectrometers. The result is that different methods are found to give different values of the wave-length, and the band is also shown to have rather a broad maximum; both of these features render it unsuitable as a standard. [See Abstracts Nos. 627 (1907), 78 (1911).]

C. P. B.

45. *Widening of Hydrogen Lines by High Pressure.* **R. Rossi.** (Astrophys. Journ. 34. pp. 299–302, Nov., 1911.)—Using a copper arc burning in hydrogen at pressures from 0·25 to 26 atmos., observations have been made on the more intense lines $H\alpha$, $H\beta$, $H\gamma$, and $H\delta$ to determine the rate of widening with pressure. All the lines increase in width with increase of pressure, the actual effect being greater for the more refrangible lines. They all seem to broaden symmetrically except $H\alpha$, which broadens out more on the violet side of the line. Within the limits of experimental error, the width increases linearly with the pressure.

C. P. B.

46. *Discharge Spectra in Gases and Vapours.* **G. Millochau.** (Comptes Rendus, 153. pp. 808–812, Oct. 30, 1911.)—Describes research on the phenomena produced in Plucker tubes enclosing gas at different pressures. In the experimental arrangement adopted, the image of the Plucker tube (Monckowen type and viewed end-on) was projected on a metallic slit, whose image was in turn projected on a circular photographic film turning very

rapidly in its own plane. The vibrations of a tuning-fork registered on the film served to determine the velocity of rotation. At the same time as the nature of the discharge was studied with this apparatus, the discharge spectrum was photographed. The author has been able to decide: (1) That the discharge can be simple or complex, that is to say, in the latter case, composed of many different simple discharges in juxtaposition or superposed on one another; (2) that a given simple discharge always corresponds, whatever the pressure, to the same spectrum in the capillary portion of the spectral tube; (3) that, when a discharge is complex, the spectrum obtained is the result of the superposition of the spectra produced by the simple discharges composing it. Seven kinds of simple discharge were obtained, which are described. These simple discharges can be divided, according to their spectral effects, into three principal groups: (i) Slow discharges, whose total duration is of the order of 0·01 sec.; (ii) Semi-abrupt discharges, total duration of the order of 0·0001 sec.; (iii) Abrupt discharges, total duration less than 0·00001 sec. To the first group of discharges correspond, in the capillary of the Plucker tube: for nitrogen, the complete positive band spectrum; for CO_2, the Swan spectrum; for the gas giving the second hydrogen spectrum, this second spectrum, very intense, especially at high pressures. To the second group seems to correspond a higher temperature of the vibrating molecule. With these discharges the group of bands between $\lambda 5000$ and $\lambda 7000$ disappears completely in the nitrogen spectrum; the CO spectrum appears in CO_2 and replaces the Swan spectrum; water-vapour gives its band spectrum; in a mixture of nitrogen and CO_2 the so-called cyanogen spectrum appears; and in the gas giving the second hydrogen spectrum, this second spectrum disappears, while the cyanogen bands become very pronounced. With the abrupt discharges of the third group only the line spectra of the substances in the tube are given; the hydrogen and He lines are in these discharges always widened. Three types of compound discharges are described. A. W.

47. *Line Spectrum of Nitrogen in a Geissler Tube.* **C. Porlezza.** (Accad. Lincei, Atti, 20. pp. 584–587, Nov. 19, 1911.)—The author has measured the wave-lengths and intensities of lines in the spectrum of nitrogen in a Geissler tube, between $\lambda = 6610$ and $\lambda = 5888$, and compares the results with those obtained by other investigators at atmospheric pressure. A grating spectrometer, having 10,000 lines per in. was employed, and the mean pressure in the Geissler tubes was about 100 mm. W. H. Si.

48. *Swan Spectrum of Carbon.* **J. Meunier.** (Comptes Rendus, 153. pp. 863–865, Nov. 6, 1911.)—The Swan spectrum, typical of the base of a candle-flame and of general hydrocarbon flames where the proportion of combustible gas is not more than a certain value, is apparently indicative of a process of oxidation and explosive combustion. The mixture of gas and air found to show the spectrum best is given as 88 to 100. C. P. B.

49. *Intensity Ratio of Series Lines of Hydrogen in Canal-ray Spectrum.* **F. Lunkenheimer.** (Ann. d. Physik, 36. 1. pp. 134–152, Oct. 8, 1911.)—Various methods of experiment were adopted, and the results obtained show that, within the limits of error, the intensity ratio of the lines of hydrogen is independent of the velocity of the emissive particles. It is probable that the intensity ratio varies with the gas pressure of the space in which the light originates. [See also Abstract No. 1848 (1907).] A. W.

HEAT.

50. *Heat of Evaporation of Water.* **A. W. Smith.** (Phys. Rev. 33. pp. 178–183, Sept., 1911.)—In previous measurements the water has been permitted to reach the boiling-point. In the method used by the author the steam was drawn by means of a current of air, from the quiet surface of water kept constantly at 98·07°; it was then condensed and the resulting water weighed. The heat of evaporation calculated for 100° is found to be 540·7 mean cals. per gm. Experiments made by the old method, in which the water is allowed to boil, gave the value 536·7 mean cals. per gm. By thus checking the boiling the heat of evaporation is increased by 4 cals. per gm. This is held to be due to the steam being all vapour in the author's method, whilst in the old method some water must have got carried over with the vapour. L. H. W.

51. *Calculation of C_2 in Planck's Equation.* **E. Buckingham** and **J. H. Dellinger.** (Bureau of Standards, Bull. 7. pp. 393–406, Oct., 1911.)—Writing Planck's equation for the intensity, J, of radiation of wave-length λ from a black body at the absolute temperature θ in the form, $J = c_1\lambda^{-5}(e^{c_2/\lambda\theta} - 1)^{-1}$, the authors point out a way of computing the constant c_2 by an extension of Paschen's method of equal ordinates. In an illustrative energy-curve for $\theta = 1442°$ abs., the constant e_2 is taken as 14,500; this gives a maximum ordinate at $\lambda_m = 2\,\mu$. E. H. B.

52. *Boiling-point of Water.* **Berkeley** and **M. P. Appleby.** (Roy. Soc., Proc. Ser. A. 85. pp. 477–489, Oct. 18, 1911.)—The phenomena attending the boiling of water were investigated with special reference to the considerable variations of temperature that appear when the rate of boiling or the height of liquid through which the steam has to pass is changed. The temperature-measurements were made differentially with the help of two Pt-resistance thermometers, one immersed in the steam of an ordinary hypsometer, and the other in a steam-jacketed tube in which water was boiled by the passage of steam from the surrounding wide-necked flask. In a typical series of measurements the excess of temperature of the water in the tube was 0·0481 deg. C. for a distillation of 1·2 c.cm. of water in 10 min., diminishing to 0·0243 deg. for a distillation of 32·8 c.cm. The temperature of the boiling liquid was raised from 0·0384 deg. above the hypsometer-temperature to 0·0620 deg. above, when the height of the liquid was increased from 5·5 to 7·8 cm. Under conditions otherwise identical, a tube 5·75 cm. in diam. gave readings 0·008 deg. lower than a tube 4·4 cm. in diam. It is shown that the excess of temperature is given by the equation $t = kah^2/(h + \beta)$, where h is the height of liquid, k a constant, and a and β are quantities depending on the rate of bubbling. The importance of this equation depends on the fact that in the case of solutions it is not possible to make use of the hypsometer temperatures, as these are identical with those of pure water; the boiling-points must therefore be measured in the liquid, and are subject to errors of the same magnitude as the differences recorded between the steam and liquid temperatures for pure water. It is perhaps on account of these errors that the cryoscopic method has been so generally preferred to the ebullioscopic method for the determination of molecular weights. T. M. L.

53. *Boiling-points of Saturated Aqueous Solutions.* **Berkeley** and **M. P. Appleby.** (Roy. Soc., Proc. Ser. A. 85. pp. 489–505, Oct. 18, 1911.)—Using the corrections described in the preceding Abstract, the following values were deduced for the boiling-points under standard conditions of a series of saturated salt solutions:—

Substance.	Boiling-point under Standard Conditions.	Osmotic Pressure.	No. of Gm.-mols. per Litre of Solution.	Osm. Press., Gm.-mols. per Litre.
	° C.	Atmos.		
NaCl	108·668	476·8	5·648	84·4
KCl...............	108·599	473·8	5·985	79·1
RbCl	118·710	748·2	7·948	93·5
CsCl	119·919	1055·0	9·214	114·5
TlCl	100·098	5·5	0·097	57·0
Na_2SO_4	102·885	162·2	2·596	62·5
K_2SO_4............	101·392	79·4	1·255	63·2
Rb_2SO_4	108·511	197·0	2·505	78·6
Cs_2SO_4	109·964	545·4	4·015	135·8
Tl_2SO_4	100·317	17·8	0·347	51·3
$NaNO_3$	120·20	1062·9	12·276	86·6
KNO_3............	115·549	838·3	12·756	65·7
$CsNO_3$	107·228	398·1	6·617	60·2
$Sr(NO_3)_2$.........	106·790	876·2	8·388	104·8
Cæsium alum..	100·527	21·2	0·300	70·1

The table shows also the osmotic pressures as calculated from the boiling-points by means of a modified form of Porter's equation, and the ratios of osmotic pressure to concentration. T. M. L.

SOUND.

54. *Auditorium Acoustics.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 120. 2a. pp. 613–684, May, 1911.)—The interest in the acoustics of rooms and halls and any enclosed spaces, and the knowledge that the intensity of the echo or reverberation is an essential factor in the phenomena, induced the author to make the present examination as to the theory of the echo in buildings. In an entirely enclosed space a simple musical sound of short duration is imagined as proceeding from a point. The sound rays are straight, and the waves suffer reflection, diffraction, and absorption at the enclosing surfaces, whether walls, floor, or ceiling. It is supposed that the mean value of the number of such incidences *per sec.* is n, and that the mean absorption coefficient (or ratio of absorbed to incident intensity) is a. Thus if a sound ray at a particular instant had the intensity E, its rate of change in dt is denoted by $dE = -Eandt$ ... (1). Whence its law of decay follows in the form $E = E_0 e^{-ant}$ ... (2), where E_0 is the energy at the time $t = 0$. Obviously the same law holds for the echo. This is in agreement with the result found in a different way by W. C. Sabine [American Architect and Building News, 68. April 7, 1900. See also Abstract No. 1740 (1906)]. The author then expresses n in terms of the total area S of exposed surface (including all decorations, &c.), and the total volume W. By a statistical and probability method it is found that $n = vS/4W$ ... (3), where v is the speed of sound. The case of a sustained simple sound of activity A is next considered. Thus in time dt its addition to the energy-density in the room is Adt/W. But in this time, apart from the supply, the energy E_0 changes to $E_0 e^{-andt} = E_0(1 - andt)$, the loss through absorption being $E_0 andt$. If the energy-density is maintained by the source in spite of this loss, we have $Adt/W = E_0 andt$ ... (4). Whence by (3) and (4) we find for the energy, which can be maintained constant, $E_0 = A/Wan = 4A/avS$ ... (5). When the supply of energy at the source is suddenly cut off we have $E = E_0 e^{-ant} = (4A/avS)\, e^{-avSt/4W}$ ... (6). It is also shown that, in the initial growth of the energy to the maximum which can be attained with the given supply, the law is expressed by $E = (4A/avS)(1 - e^{-avSt/4W})$ ... (7). [The analogy between (6) and (7) and the Helmholtz formulæ for currents in an inductive circuit is noteworthy.] The values of the absorption coefficients are quoted from the work of W. C. Sabine as follows :—

Surface.	a.
Open window	1·000
Pine boarding	0·061
Plaster over laths	0·034
Single glass	0·027
Plaster on brickwork	0·025

The product aS in any of the formulæ is obviously the sum of a number of such products, or $aS = a_1S_1 + a_2S_2 + \dots$ (8). Hence the introduction of each member of an audience adds another product, $a\sigma$ say, to the series on the right of (8). Thus m persons, practically alike, add the term $ma\sigma$ to the value of aS. An examination of equations (6) and (7) shows that the greater the value of aS the less the max. energy that can be attained in the room by a source of sound of limited activity A, but the rise to the maximum is sharper and the duration of the echo shorter, though the time of rise and fall depend also upon the total volume W of the room in question. The variation of the absorption coefficient with the frequency of the tones in question is also dealt with. Thus the higher the tone the more is reflected and the less absorbed [O. N. Rood, Sill. Journ. 3. vol. 19. p. 183, 1880]. E. H. B.

55. ***Variation of Resonance with Tuning.*** **R. Hartmann-Kempf.** (Ann. d. Physik, 36. 1. pp. 74–90, Oct. 3, 1911.)—Describes some new experiments on the dependence of the resonance on the frequency adjustment, and its falling-off as the mistuning increases. The first part of the paper deals with (*a*) freely-swinging, and (*b*) strongly-damped elastic bodies; the second part with the reaction on each other of vibrating reeds of nearly the same frequency. A number of resonance curves are given showing variation of amplitude with tuning. [See Abstract No. 1111 (1904).] E. H. B.

56. ***Pitches of Sounds from Alloys and their Variation with Temperature.*** **F. Robin.** (Comptes Rendus, 153. pp. 665–668, Oct. 9, 1911.)—The author's experiments show that the presence of chromium in steel raises the pitch of the note from a fork, and that nickel lowers the pitch. Certain alloys are mentioned for which the variation of pitch with temperature is very small, viz.:—

Ni (44·5) Mn (2), from 0° to 50°;
Ni (47) Cr (3), from 0° to 60°;
Ni (42·4) Cr (1·5), from 0° to 100°;
Ni (45) from 0° to 100°, and from 180° to 280°.

These alloys are recommended for use in forks as standards or as chronographs, their pitches being practically constant within the ranges given. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

57. *Charges on Nuclei.* **K. Przibram.** (Akad. Wiss, Wien, Sitz. Ber. 120. 2a. pp. 639–662, May, 1911.)—Continuing previous work on the method of F. Ehrenhaft, but now using an improved condenser, the author obtains a number of values for the electric charges on nuclei, which form a contribution to the question as to the elementary electric charge *e*. For very small nuclei the present author finds values for *e* longer than 5. Thus, for radii under 8×10^{-5} cm. the value of *e* has the characteristic figures 5·82. [See Abstract No. 1198 (1911).] E. H. B.

58. *Electrostatic Calculations.* **V. Karapetoff.** (Lumière Électr. 16. pp. 272–275, Dec. 2, 1911. Abstract of paper read before the Internat. Electrical Congress, Turin, 1911.)—The author suggests that the word "permittance" should be used instead of "capacity." The elastance is the reciprocal of capacity. The permittance being expressed in farads, the elastance is measured in darafs. He then gives electrostatic formulæ which contain neither 4π nor 8×10^{10}. Numerical examples illustrating the use of the new units are worked out and a table of their dimensions is given. A. R.

DISCHARGE AND OSCILLATIONS.

59. *Ionisation of Gas by Canal Rays.* **R. Seeliger.** (Phys. Zeitschr. 12. pp. 839–842, Oct. 15, 1911.)—This is a preliminary communication in which the method adopted and the apparatus employed are explained. The rays are generated in a discharge tube and proceed through a capillary tube into the observation space. There they pass through a plate condenser and are then caught by a Faraday cylinder. The saturation current (S) between the condenser plates, and the current (A) in the cylinder are measured simultaneously. The results obtained vary from day to day, although those obtained on any one day are in good accord. Whenever the gas is changed very different initial values are obtained. For hydrogen at about 1/100 mm. pressure the value of S/A is about 1. In oxygen the corresponding value is roughly 4 times as large. The number of ions generated appears to be proportional to the pressure. No dependence of the ionisation upon the discharge potential is noted. A. E. G.

60. *Variation of Ionising Power with Velocity of Kathode Rays.* **J. L. Glasson.** (Phil. Mag. 22. pp. 647–656, Oct., 1911.)—A beam of kathode rays was separated out by a magnetic field and a thin homogeneous pencil of known velocity was directed into an ionisation chamber and received by an electrode consisting of a Faraday cylinder. From the charges received by the Faraday cylinder with positive and negative fields the amount of ionisation per kathode ray was estimated, and it was found that: 1 kathode ray moving with a velocity of $4·8 \times 10^9$ cm. per sec. makes 1·5 pairs of ions in traversing 1 cm. in air at a pressure of 1 mm. Hg. In the region examined, that of velocities between 4 and 6×10^9 cm. per sec., the rate of variation of the ionisation with the velocity of the kathode rays was found to be intermediate between an inverse first-power and an inverse second-power law, being much nearer the latter than the former. [See Abstract No. 1500 (1911).] E. M.

61. *Flame arising from Nitrogen-burning Arc.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 85. pp. 533–536, Oct. 18, 1911.)—If a Ruhmkorff coil or other form of high-tension transformer is supplied with alternating current in the primary circuit, an arc can be struck between the secondary terminals. A similar arc is obtained, using a direct current interrupted by a Wehnelt or mercury-turbine break. In hydrogen the discharge stretches straight across between the electrodes without appreciably rising into an arch. In pure nitrogen the phenomena are similar, except that the discharge tends to rise into an arch, particularly if the terminals are widely separated. In pure oxygen an arch is also formed. With air an entirely new phenomenon makes its appearance. The arc is there as before, stretching from one terminal to the other, with a slight rise in the middle. But around and, more particularly, above it, is an envelope of yellowish-green flame. At atmospheric pressure the arc may be examined by the aid of a deep violet glass which cuts out the light of the flame. The distinction between the arc and the flame may also be made apparent by slightly reducing the pressure. The greenish-yellow flame is shown to be in complete continuity with the "after-glow" phenomenon in vacuum tubes containing air. The latter can be proved to be due to the further oxidation of oxides of nitrogen by ozone. Accordingly it is concluded that the flame arising from the arc is due to the same cause. The arc produces ozone and oxides of nitrogen. These substances, independently produced, unite chemically in the region above and around it. The greenish-yellow flame is developed in the process. A. E. G.

62. *Influence of Earthed Surroundings on Sparking Potentials between Spheres.* **E. Hupka.** (Ann. d. Physik, 36. 2. pp. 440–448, Oct. 13, 1911.)—The aim of the experiments is the measurement of the sparking potentials for one and the same pair of spherical electrodes at different distances apart, first when the earthed part is removed as far as possible from the sparking apparatus, and then in an earthed arrangement similar to that used by C. Müller [see Abstract No. 881 (1909)]. The influence of the earthed surroundings can in this way be ascertained. It is proved that they have a distinct effect upon the sparking potential. In the results given, the effect produced is generally less than a difference of 3000 volts. It therefore does not appear possible that the much greater differences (about 20,000 volts) between the results of C. Müller and of M. Töpler [Abstract No. 1760 (1909)] can be explained by the influence of earthed surroundings alone. A. E. G.

63. *Sound Intensity of the Singing Arc.* **W. Rihl.** (Ann. d. Physik, 36. 3. pp. 647–680, Nov. 9, 1911. Extract of Dissertation, Göttingen.)—An experimental research of which the chief results may be summarised as follows:— (1) With constant direct current and constant strength of the overlying sine alternating-current, the intensity of the sound increases proportionally to the square of the length of the arc. (2) With constant arc length and constant direct current the sound intensity increases as the square of the alternating current. (3) With constant arc length and constant alternating current, but changing direct current the sound intensity follows the same law as the potential of the arc with change of direct current. [See Abstracts Nos. 526 and 1157 (1898), and 846 (1901).] E. H. B.

64. *Influence of the Spark in Condenser Circuit Discharge.* **D. Roschansky.** (Ann. d. Physik, 36. 2. pp. 281–307, Oct. 13, 1911.)—A Braun tube is described by which it is possible to investigate and photograph electrical oscillations of frequencies up to 3×10^6 per sec. The kathode discharge must be very intense, and therefore the tube must be very "hard," say, so that the discharge through the tube almost prefers to pass through 7 cm. in air. Behind the kathode is a metal shield and packing of tin-foil. After the rays have passed through the anode, they are concentrated by the axial magnetic field of a current passing through a coil which is wound round the tube. The p.d. between the sides of the spark-gap of a condenser circuit during discharge is investigated by the electrostatic deflection of the rays. The method is given in an earlier paper [see Abstract No. 2009 (1908)]. The amplitude of the p.d. varies only slightly during the course of the discharge, increasing towards the end of the discharge when silver electrodes are used, and decreasing when magnesium electrodes are used, at least for wave-lengths greater than 400 m. The relation between the p.d. and spark-length is linear. The p.d. is of the same order for most metals and the damping of the oscillation is influenced only to a small extent by the material of the electrode. The magnitude of the p.d. indicates that the ordinary form of spark discharge is analogous to an arc, but at the instant when the arc is quenched a brief glow discharge passes. With regard to the damping due to the spark, it is shown that in those cases in which the spark p.d. remains almost constant during the course of the discharge, the amplitude of the oscillation falls off each period by a constant amount, if the other energy losses are eliminated. T. P. B.

65. *Refraction of Very Short Electric Waves in Liquid Air.* **H. Merczyng.** (Acad. Sci. Cracovie, Bull. 8A. pp. 489–492, Oct., 1911.)—The intensities of the beam of electric waves reflected from mercury and from liquid air were observed by a thermo-element, the ratio of the latter to the former being denoted by R. Then, as previously shown, the index of refraction is given by $n = \sqrt{(y^2 + \sin^2 i)}$, where $y = \cos i(1 + \sqrt{R})/(1 - \sqrt{R})$, i being the angle of incidence. For a wave-length $\lambda = 4·5$ cm. the author thus finds for the index of refraction of liquid air $n = 1·51$. [See Abstracts Nos. 1627 (1910) and 516 (1911)]. But (Mme.) M. D. Petrowa found by the condenser method $D = n^2 = 1·33$ (Russ. Phys. Soc. Journ., 1907). Hence, for infinitely long waves, $n_\infty = \sqrt{D} = 1·16$; showing an abnormal dispersion as found for the optical spectrum by Liveing and Dewar (Phil. Mag. 34. p. 205, 1892, and 36. p. 330, 1893). E. H. B.

66. *The Carriers of Electricity in Gases.* **A. Becker.** (Ann. d. Physik, 36. 2. pp. 209–280, Oct. 13, 1911.)—This paper deals with the subject in an exhaustive manner under the following heads; for details the original paper must be consulted: (*a*) *A summary of previous investigations.* (*b*) *Carriers generated by Röntgen rays.* (1) The method of research. (2) The largest carriers. Under this is treated the influence of the age of the carriers and the influence of vapour. (3) The smallest carriers. (*c*) *The fog nuclei produced by ultra-violet light.* (1) Method of research. (2) The larger carriers. (3) Influence of the intensity of the light. (4) Magnitude of the fog nuclei. (5) The nuclei at high and low temperatures. (6) Manner in which the nuclei are produced. (*d*) *Carriers generated by kathode rays.* (1) Fog nuclei. (2) Mobility curves. (3) Very small influence of foreign vapours. (*e*) *The formation of fog nuclei through ozone in gases containing*

vapour. (1) The nature of the active vapour. (2) Dependence of the number and magnitude of the carriers upon the concentration of the nuclei-forming substance. (3) Influence of hydrogen on the formation of nuclei. (4) Temporary increase of fog nuclei. (5) The mechanism of the formation of nuclei. A. E. G.

67. *Mean Flow of Energy from Three Hertzian Doublet Oscillators.* **K. Tamaki.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 129–136, July, 1911.)—A mathematical paper giving the mean flow of energy in various directions around three Hertzian oscillators, according to the phase-differences of the oscillations. The oscillators are placed in a line at equal distances from one another. [See also Abstract No. 1009B (1910).] T. P. B.

68 *Energy Radiated by a Hertzian Oscillator.* **K. Tamaki.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 121–127, July, 1911.)—A mathematical paper which cannot be abstracted. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

69. *Electrical Conductivity of Liquid Sulphur Dioxide Solutions.* **E. C. Franklin.** (Journ. Phys. Chem. 15. pp. 675–697, Oct., 1911.)—Measurements were made of the electrical conductivity of solutions in liquid sulphur dioxide of potassium iodide and bromide, tetraethylammonium iodide, ammonium sulphocyanide, ethylammonium bromide and dimethybammonium chloride. The measurements were made at — 33·5°, — 20°, — 10°, 0°, and + 10° C. It was found that the molecular conductivity, in addition to rising towards a maximum at infinite dilution, gave max. values at about normal concentration, the two maxima being separated by a shallow minimum at about N/10. The maximum and minimum were most pronounced at the higher temperatures. This is associated with the fact that whereas the temperature-coefficient of conductivity is positive for the very concentrated and for the most dilute solutions, it becomes negative for solutions of intermediate concentrations. T. M. L.

70. *Electric Properties of the Alkaline Metals, of Rhodium and of Iridium.* **Broniewski** and **Hackspill.** (Comptes Rendus, 153. pp. 814–816, Oct. 30, 1911.)—The thermoelectric properties and the e.m.f. of solution of pure specimens of the alkaline metals were studied. The caesium, rubidium, and potassium were prepared by the method described by Hackspill (action of Ca on the chlorides) and redistilled *in vacuo.* The sodium employed was that of commerce, also redistilled. After their distillation the metals were directly introduced whilst maintaining the vacuum (about 0·001 mm.) into glass tubes furnished with Pt electrodes. The measurements of the e.m.f. were made between 0, —78° and — 183° with reference to copper, whose thermoelectric power against lead was exactly known. The following are the values in microvolts found for the thermoelectric power with reference to lead:—

Metal.	Thermoelectric Power *dE/dt.*
Cs	$+\ 0{\cdot}66 - 0{\cdot}0010t$
Rb	$-\ 8{\cdot}26 - 0{\cdot}0802t$
K	$-11{\cdot}33 - 0{\cdot}0376t$
Na	$-\ 4{\cdot}16 - 0{\cdot}0144t$

In the curves showing the variation of the thermoelectric force with temperature of Cs and Rb referred to copper the point of fusion of Rb (38°)

is marked by an angular point on the curve, that of Cs (28°) is indicated by a break in the curve. The thermoelectric power of liquid Cs and Rb with reference to lead is expressed by the following formulæ.

Cs .... $dE/dt = +6{\cdot}80 - 0{\cdot}0384(t-28)$
Rb .... $dE/dt = -2{\cdot}56 - 0{\cdot}0600(t-38)$

The same specimens of the alkaline metals were used for measuring the e.m.f. of solution, for which the following values were found :—

Metal	Cs	Rb	K	Na
E.m.f. in volts ...	3·3	3·1	3·2	3·2

Rhodium and iridium were examined in the form of wires of rectangular section, and the following numbers were obtained for their electric properties :—

Temperature.	Resistivity of Rhodium.	Resistivity of Iridium.
+ 100°	6·60	8·31
0	4·70	6·10
− 78·3	3·09	4·28
− 186	0·70	1·92

Thermoelectric power with reference to lead from − 78° to 100° :—

For Rhodium .... $+2{\cdot}17 + 0{\cdot}0005t$
For Iridium .... $+2{\cdot}44 - 0{\cdot}0014t$ J. J. S.

71. *Thermoelectric Forces on Melting.* **P. Cermak and H. Schmidt.** (Ann. d. Physik, 36. 3. pp. 575–588, Nov. 9, 1911.)—After experimenting with thermoelectric couples of lead-tin, tin-constantan, tin-iron, and lead-constantan, the authors find no discontinuity of the thermoelectric force or of the thermoforce per degree, whether one of the metals is solid or liquid. [See Abstracts Nos. 1475 (1908) and 1394 (1911).] E. H. B.

72. *Influence of Magnetisation on Thermoelectric Power.* **U. Bordoni.** (N. Cimento, 2. Ser. 6. pp. 245–290, Oct., 1911.)—Experiments with wires of Cu, Ag, Mn, and Zn confirm the independence of the magneto-thermoelectric phenomenon of the sign of the magnetisation and of the nature of the other metallic constituent of the couple. Curves are given showing the variation of the e.m.f. of couples of Cu with Fe, steel, and Ni, with temperature of the junctions, and intensity of magnetisation. For six Cu-Fe couples, longitudinal magnetisation of the iron increases the e.m.f., the increase being greater, for the same magnetisation, with increase of difference of temperature between the junctions, and for a given temperature-difference between the junctions, increasing with the intensity of magnetisation until a maximum is reached, after which the increase becomes less. Examination of 18 Cu-steel couples, including steels containing not only C and Si, but also W, Cr, and Mn, shows that the magneto-thermoelectric phenomenon varies with the quality and the state of the steel, but, arranging the materials in a scale ranging from soft iron to hard tempered steel, the corresponding magneto-thermoelectric diagrams form a series, changing always in the same sense. Magnetised soft iron is always thermoelectrically positive with respect to the same iron non-magnetised, while magnetised tempered steel is always thermoelectrically negative with respect to the unmagnetised steel, and in general, the tendency of the magnetised material to become thermoelectrically negative with respect to that not magnetised increases with the hardness, intensity of magnetisation, and temperature-difference between the junctions. Contrary to the results of Houllevigue, the variation in e.m.f. is never found to exceed 12–15 microvolts. With six Cu-Ni couples the e.m.f. is decreased by longitudinal magnetisation, showing magnetised Ni to be thermoelectrically positive with respect to non-magnetised Ni. In the measurement of variation of the e.m.f., a microgalvanometer of the Deprez-D'Arsonval type, fitted with a bobbin of very fine wire of Chatterton composition, has been employed, and a note is appended describing the preparation and properties of this wire. W. H. Si.

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73. *Heating Effect of Currents in Resistance Measurements.* **R. T. Glazebrook, W. R. Bousfield, and F. E. Smith.** (Roy. Soc., Proc. Ser. A. 85. pp. 541–556, Oct. 18, 1911. Electrician, 68. pp. 521–522, Jan. 5, 1912. Abstract.)—Bousfield has described experiments in which the resistance of a wire was found to increase with the passage of a current by an amount which was thought to be too large to be accounted for by the rise of temperature of the wire. The present paper describes further experiments made with a large number of wires, the results showing that with annealed wires the increase of resistance is substantially due to the increase of temperature. However, it is at present difficult to say whether or no the change in specific resistance which sometimes occurs, when large currents are used—especially with unannealed wires—is due entirely to the change of temperature of the wire. In the case of coils immersed in oil the importance of uniform stirring is emphasised. Thus with a 0·8-mm. copper wire the following results were obtained with a current of 8 amps. :—

Normal stirring ... ... Resistance = 1·0088
Very vigorous stirring ... " = 1·0027
No stirring ... ... " = 1·0178

In an appendix the exact relation of the effect to the radius of the wire is investigated, and it appears that the "emissivity" of a round wire in contact with a liquid cooling agent is proportional to the inverse square root of the radius when the other conditions of convective action are kept constant. F. E. S.

74. *International Ampere in Absolute Measure.* **E. B. Rosa, N. E. Dorsey,** and **J. M. Miller.** (Washington Acad. Sci., Journ. 1. pp. 211–218, Nov. 19, 1911.)—A brief description of the new current-balance constructed at the Bureau of Standards, full particulars of which will soon be published. In terms of the int. ohm. and the ampere (10^{-1} c.g.s.) the e.m.f. of the Weston normal cell at 20° C. has been determined to be 1·01822, and the absolute value of the electrochemical equivalent of silver as obtained with two types of voltameter is 1·11804 mgm. per coulomb. The value adopted by the London Conference in 1908 was 1·11800. F. E. S.

75. *Lightning Protection for Observatories at High Altitudes.* **J. Vallot.** (Comptes Rendus, 153. pp. 986–988, Nov. 13, 1911.)—Both the Janssen Observatory and the laboratory on the summit of Mont Blanc have repeatedly been struck by lightning; the former is provided with lightning conductors, the latter not; extraordinary electric phenomena of long duration were frequent in the former. Both these wooden buildings rest on snow or ice. On the other hand, the Observatoire des Bosses, also on Mont Blanc, which stands on the rock and is insulated in Faraday-cage fashion, has never

been struck in thirteen years; the instruments inside are not joined to the conductors. No means are known for securing the safety of buildings which stand on the snow at a considerable distance from the rock. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

76. *Von Waltenhofen Phenomenon in Soft-iron Rings.* **L. A. Babbitt.** (Amer. Acad., Proc. 47. No. 8. pp. 229–264, Nov., 1911.)—v. Waltenhofen has observed that when the field in a solenoid used to magnetise a soft-iron rod is suddenly reduced to zero by breaking the circuit, the remanent magnetism of the iron is, under certain circumstances, opposite in direction to that induced by the field just applied. This result has been ascribed to the inertia of the elementary magnets. The author has accordingly conducted experiments on soft-iron rings to determine how the manner of growth of a magnetising field of given final intensity affects the change which the field produces in the magnetic condition of the specimens. He finds that in the early stages of its magnetic history the condition of the iron in all the toroids tested is constantly changing. During this stage of transition no given condition can be repeated by any of the ordinary methods of demagnetisation and remagnetisation. But as the mass is subjected again and again to the magnetising process it attains more and more nearly to a condition such that, for all practical purposes, any magnetic state may be repeated as often as desired. The process of demagnetisation affects, by the manner in which it is carried out, the first few hysteresis curves which follow, altering the max. induction attained when the max. field is applied. In the case of a large solid mass of iron the form of the hysteresis curve depended upon the number of steps employed in the test. This did not hold in the case of finely-divided masses, both large and small. Eddy currents and not any inherent property of the iron must therefore be regarded as causing the phenomenon. A. D. R.

77. *Magnetic Properties of Iron electrically deposited in a Magnetic Field.* **R. Gans.** (Phys. Zeitschr. 12. pp. 911–917, Nov. 1, 1911.)—C. Maurain has shown [see Abstract No. 2235 (1900)] that the magnetisation curve for electrolytic iron differs considerably accordingly as the iron has or has not been deposited in a magnetic field. The form of the hysteresis curve in the former case resembles that which Weiss has obtained for pyrrhotin in fields applied in a definite direction in the so-called direction of easy magnetisation. It has therefore been conjectured that in a magnetic field the iron particles were oriented as they were produced so that a magnetic crystal was built up. The author has carried out experiments to test the æolotropy as regards magnetism of iron deposited in a magnetic field. The paper gives details and results of the tests, the apparatus being similar to that used by Weiss in his investigations on pyrrhotine. The conclusion arrived at is that an æolotropy of iron produced by the application of a magnetic field is of an entirely different order to that found in pyrrhotine, and hence the effects found by Maurain and others are due to something else than an orientation of the elementary complexes in *statu nascendi*, produced by the action of the field with a consequent departure from isotropy. A. D. R.

78. *Pseudo-Hall-effect with High-frequency Currents.* **H. Zahn.** (Ann. d. Physik, 36. 3. pp. 553–574, Nov. 9, 1911.)—It is shown that when a metal

plate is conducting a high-frequency current, and is placed in a magnetic field which is in phase with current in such a way that the field is perpendicular to the plate, effects may be observed which are very similar to the "Hall-effect," but much more intense. The experiments prove that these effects are due to currents induced in the plate, which in conjunction with the current through the plate produce a temperature-difference between the sides of the plate, and therefore, if suitable connecting electrodes are fixed to the sides, a thermoelectric current through a galvanometer connected with the electrodes. By suitably altering the phase-difference between the current and the magnetic field a sharp minimum of the temperature-difference may be brought about, and it is indicated how a null-method of making certain high-frequeney measurements may be based on this fact. T. P. B.

79. *The Transverse Thermomagnetic Effect in Nickel and Cobalt.* **A. W. Smith.** (Phys. Rev. 33. pp. 295–306, Oct., 1911.)—When a metal plate, through which there is a longitudinal flow of heat, is brought into a magnetic field so that the lines of force are perpendicular to the plane of the plate, there is set up by the magnetic field a transverse e.m.f. given by the equation $E = Q\beta H \cdot \partial T/\partial x$. Here E is the e.m.f. in absolute units, β the width of the plate in cm., H the magnetic field in absolute units, $\partial T/\partial x$ the temperature gradient in the plate in deg. C. per cm., and Q is a constant which is a function of the temperature of the plate, and sometimes of the magnetic field. This phenomenon is known as the transverse thermomagnetic effect, or as the Nernst-effect. Experiments were made to investigate its variation with the temperature of the plate, and its relation to the Hall-effect and to the magnetic properties. The chief results obtained are as follows: (1) On examining the relation between the Nernst e.m.f. and the magnetic field in nickel at a number of temperatures between 56° C. and 410° C. it was found that for a given magnetic field the e.m.f. increased with rising temperature until the critical temperature was reached. The rate of increase becomes greater the nearer the critical temperature is approached. In passing the critical temperature the Nernst-effect sinks to a small fraction of its value at that temperature, and then probably decreases with further rise of temperature. (2) For any particular temperature below the critical temperature the Nernst e.m.f. is at first proportional to the magnetic field, but when the intensity of magnetisation approaches its maximum there is a rapid deviation from this proportionality, and the e.m.f. approaches a limiting value at higher magnetic fields. Since the max. intensity of magnetisation decreases with rising temperature, the fields necessary to produce saturation become less as the temperature is increased. (3) At temperatures above the critical temperature the Nernst e.m.f. is proportional to the magnetic field. (4) In Co the Nernst e.m.f. is proportional to the magnetic field between 56° and 550° for the range of magnetic fields used in the experiments. (5) In Ni the Nernst-effect increases more rapidly than the Hall-effect with rising temperature, and in Co it increases less rapidly than the Hall-effect. In this respect Co behaves like iron. J. J. S.

80. *Magnetism of Salts of Metals of the Iron Group.* **R. H. Weber.** (Ann. d. Physik, 36. 3. pp. 624–646, Nov. 9, 1911.)—The author summarises and compares the results obtained by him, and published in previous papers [Abstract No. 1121 (1906)], with those of Liebknecht and Wills. The susceptibility of the salts is expressed in terms of the atomic magnetism K, which quantity is equal to *km*, where *k* is the specific susceptibility (*i.e.*, the susceptibility of the salt when it is so diluted that 1 gm. occupies 1 c.cm.) and *m* is the molecular weight divided by the number of metal atoms in the salt molecule. The following table gives the chief results :—

Salt.	K.	Observer.
$CrCl_3$	0·00625	Weber
$CrCl_2$	0·01078	Weber
$MnPO_4$	0·01084	Weber
$Mn(SO_4)_2$	0·01514	Liebknecht and Wills
$Fe_2(SO_4)_3$	0·01515	Liebknecht and Wills
$FeSO_4$	0·01272	Liebknecht and Wills
$Co_2(SO_4)_3$	<0·00486	Weber
$CoSO_4$	0·01019	Liebknecht and Wills
$NiSO_4$	0·00435	Liebknecht and Wills

A. D. R.

81. *Magnetic Chart Errors and Secular Changes in Indian Ocean.* **L. A. Bauer** and **W. J. Peters.** (Terrestrial Magnetism, 16. pp. 183–186, Sept., 1911.)—Exceptionally large errors are being found from the recent charts determined from the *Carnegie* observations in the Indian Ocean. In the majority of cases given, the chart errors are *negative* as regards west declination, and in amount run up to as much as 4°. These serious errors, while partly due to defective spacing of the lines of equal magnetic declination, are to be referred chiefly to erroneous secular changes in bringing the chart readings up to date. Special observations are being made to include readings on the route taken by the *Gauss* in 1903, to define the locality where the secular change passes through zero value and then changes sign. C. P. B.

82. *Magnetism of Nickel and Cobalt and their Alloys.* **P. Weiss** and **O. Bloch.** (Comptes Rendus, 153. pp. 941–943, Nov. 13, 1911.)—The author discusses the laws previously found for nickel-irons, viz., that the saturation intensities, the Curie constants, and the constants of the molecular field, vary as linear functions of the percentage composition. In this paper similar laws are shown to hold for Ni-Co alloys. A. D. R.

RADIOLOGY AND ELECTROPHYSIOLOGY.

83. *Secondary Rays produced by Röntgen Rays.* **C. G. Barkla.** (Röntgen Soc., Journ. 7. pp. 87–96; Discussion, pp. 97–98, Oct., 1911.)—The paper gives a brief outline of the subject and forms a useful introduction to the original papers, a list of which is given. The general conclusions arrived at are as follows: It is possible to get rays of any definite penetrating power by a proper choice of radiating element and so the possible mischief of penetrating rays can be avoided. A table is given which shows what element should be used to emit radiation to penetrate to a given depth. A plate of the substance should be placed near the body to be treated, and exposed to the primary radiation from a tube, while the body itself is protected from the direct radiation. The treatment of internal organs might in many cases be made much more efficient, and other portions of the body protected, by the use of penetrating primary rays which produce little effect of any kind except in the neighbourhood of elements of high atomic weight. This would be done by heavy substances in or near the organ to be treated. A means of gauging the dose of secondary rays is described. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

84. *Distillation of Amalgams and the Purification of Mercury.* **G. A. Hulett.** (Phys. Rev. 33. pp. 307–316, Oct., 1911.)—After discussing the methods ordinarily in use for the purification of mercury, the author states that the only effective way of removing metallic impurities is by distillation; from results given in the paper it would seem to require two or three distillations if Ag, Au, or the Pt metals are present, Ag being the most difficult metal to remove. In the case of such metals as Zn, Cd, Pb, Sn, and Bi, which have comparatively low melting-points and high vapour pressures, it would take many distillations to remove these metals satisfactorily, if the distillation were carried out in a vacuum or in a reducing atmosphere. All oxidisable metals may, however, be removed effectively by a single distillation if air is allowed to bubble through the amalgam in the still and pass over with the mercury vapour. Apparently the oxidation of the base metal occurs in the vapour phase and not to any extent while the air is bubbling through the amalgam in the still. Evidence is given to show that absorption of oxygen by mercury at ordinary temperatures, or even at 100°, does not take place. Two apparatus are described for the distillation of mercury, the one being used for small [Abstract No. 402 (1906)], and the other for large quantities. T. S. P.

85. *Calculation of the Loschmidt number with the help of the Theory of Liquids.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 120. 2a. pp. 685–687, May, 1911.)—The Loschmidt number, $Z = MN/\rho$, which represents the number of molecules in a gm.-molecule of liquid, has been calculated for mercury. The value of N, the number of molecules in unit volume, is obtained from the relationship $N = 6/\pi\sigma^3$, where $\pi\sigma^3/6$ is the volume of a molecule. σ, the diam. of a molecule is obtained from the relationship, $P = 8c\eta/5\sigma$, where c is the mean velocity of the molecules, η the coefficient of viscosity, P the internal pressure [Abstract No. 908 (1902)]. The value calculated for mercury is $Z = 612 \times 10^{21}$, which is an excellent agreement with the number given by various investigators. On calculating from this the value of unit charge, in e.s. units, the author obtains, $e = 4{\cdot}73 \times 10^{-10}$, a value which lies within the limits of all those obtained during 1908 and 1909. A. F.

86. *Crystalline Liquids.* **H. v. Wartenberg.** (Phys. Zeitschr. 12. pp. 837–839, Oct. 15, 1911).—*p*-azoxyanisol and *p*-azoxyphenetol in the form of liquid-crystals behave as uniaxial crystals with positive double-refraction when placed in a magnetic field. The temperature at which the substance becomes clear and isotropic is not affected by a magnetic field of 7200 gauss. This was tested on a specimen in which a temperature gradient was arranged so as to bring the boundary between the phases to the centre of the field of view; the position of the boundary was not altered by the magnetic field. T. M. L.

87. *Experiments with an Electric Vacuum Furnace; some Melting-points.* **O. Goecke.** (Metallurgie, 8. pp. 667–676, Nov. 8, 1911.)—The author has improved the furnace of O. Ruff (Ber. Deutsch. Chem. Gesell. p. 1564, 1910), which can

be used either as arc furnace (with vertical electrodes), or as resistance furnace (crucible in a vertical tube). The crucible is so suspended from the upper carbon that it can be dropped through the lower carbon into ice water for quenching; the lower electrode is mounted on a spiral spring and is easily removable. A second (radiation) tube surrounds the furnace; the iron body is a one-piece casting. Temperatures are measured with two Wanner pyrometers and also with Seger cones. These cones would not bear a vacuum above 1825°, because some alumina distilled off; this decomposition did not take place in nitrogen at atmospheric pressure, however, and the observed melting-points agreed well with those marked by the manufacturer under both conditions. The materials generally rested on cushions of their own substance in the crucible. Some fireclays melted between 1700° and 1800° C. Aluminium oxide melted between 2020 and 2035°, both in a vacuum and in nitrogen (atmospheric pressure); some vapours appeared at 1690° C. and condensed to crystals, but a boiling-point could not be observed. Calcium oxide evaporated about 2000° C., yielding needle crystals, but there was no boiling, nor any melting at reduced pressure; in nitrogen vapours appeared at lower temperatures, and melting resulted at 1990° C., owing to some chemical reaction probably. Magnesium oxide boiled at 2029° C. when the pressure was 7 mm.; in nitrogen vapours were observed at 1800° already. Melting of MgO could not be produced in either case at temperatures up to 2450° C. H. B.

88. *Carbon deposited as Diamond.* **W. v. Bolton.** (Zeitschr. Elektrochem. 17. pp. 971–972, Nov. 15, 1911.)—In 1910 the author observed that carbon mirrors apparently containing minute diamond crystals were deposited when mercury vapour, liberated from sodium amalgam, interacted with hydrocarbons (coal-gas). Resuming these experiments he charged a test-tube with sodium amalgam, smeared the free inner glass surface of the tube with sodium silicate and strewed diamond powder on the silicate; the powder was amorphous, and showed only a few crystals under the microscope. The tube was kept in a water bath at 100° C. for four weeks while moist coal-gas was passed through it. Part of the powder turned black; after extracting with hydrofluoric acid and sulphuric acid, it was found to consist essentially of minute crystals which disappeared when heated in oxygen or when fused with sodium carbonate. H. B.

89. *Electric Fusion of Quartz.* **O. Vogel.** (Elektrochem. Zeitschr. 18. pp. 121–126, Aug.; 181–185, Oct., and pp. 218–222, Nov., 1911.)—The fusion of silica, especially of sand grains and still more of powdered crystal, is very difficult owing to the low thermal conductivity of silica, as the author proves by experiments. Yet silica can really be melted without much loss by evaporation, although this is often denied. When treated in a carbon tube, the melting sand flows down into a vertical tube, and when this tube is conical, the product shows complete fusion in the lower narrow portions, while in the upper, wider portions the grains can still be distinguished. Slowly-heated quartz turns crystalline like marble, because it loses water. When tubes are formed by heating the sand from outside (carbon tube) and inside (carbon core), both walls will be glazed, but the inner mass may still be crystalline. The furnace of the author is conical. The walls are formed by baking the oxides of Zr and Th together with oxide of La (added to increase the conductivity); behind this wall is carbon in connection with the large carbon electrodes, one in the upper portion, the other below surround-

ing the narrow outlet. The carbon wall is again backed by silicides of carbon and boron. The melting quartz (temperature 1800° C. below, 700° above), passes through three chambers, in which it is further heated by resistance, for clarification. Fused quartz conducts the current. H. B.

90. *Electric Smelting of Arsenious Copper Sulphide.* III. **J. Schilowski.** (Metallurgie, 8. pp. 617–625, Oct. 8, 1911.)—In continuation of former experiments [see Abstract No. 747 (1910)] pyrites containing 10 per cent. of Cu, 27 of Fe, 20 SiO_2, 9 As, 15 S, 10 of Al_2O_3 were smelted, after roasting, without additions, in electric furnaces of the Borchers type (carbon rod between the upper and lower electrodes), or with two suspended electrodes, combined with condensing chambers. A matte free of As is obtained, and most of the As condensed. H. B.

91. *Copper-Silver-Gold System.* **E. Jänecke.** (Metallurgie, 8. pp. 597–606, Oct. 8, 1911.)—This system has been studied thermally with the aid of a string galvanometer and a specially-designed chronographic recorder. A preliminary investigation of the Au-Ag system showed that the liquidus is much less convex than that determined by Kirke-Rose and Roberts-Austen. In all, 64 ternary alloys were prepared, and the results combined in a triangular equilibrium diagram which shows a minimum running from the Cu-Au minimum to the Cu-Ag eutectic. A line CBD (C and D being close to the concentrations of the solid solutions in the Cu-Ag series, and B at a concentration of 42·5 atoms per cent Cu, 33·5 Ag and 24·0 Au) divides the diagram into two parts. In the area CBD the alloys give two arrests on cooling, and show a duplex structure under the microscope, while outside the area CBD the alloys show only one arrest and are homogeneous. The thermal and microscopic results are in complete accord. F. C. A. H. L.

92. *Effect of Temperature upon the Ductility of Zinc.* **W. B. Haines.** (Roy. Soc., Proc. Ser. A. 85. pp. 526–532, Oct. 18, 1911.)—Describes experimental work on the examination of the ductility of zinc wire at various temperatures. Wires about 15 cm. long were fixed in a vertical position in a bath of castor oil and stretched by a weight applied to the upper end by means of a pulley. A cathetometer was used to measure the extension of the wire, and at each particular temperature the rate of extension was calculated from the observations for several loads ranging up to the breaking stress. The effect of heating commercial zinc wire is a gradual softening up to about 90° C., the metal becoming remarkably soft between 80° and 90°. At a few degrees above 90°, a hardening sets in, which is so rapid that at 110° the behaviour is comparable with that at 80°; there is, however, greater brittleness than at this lower temperature. From 110° onward there is a regular softening as the temperature rises, which continues up to 200°. The effect of heating above 120° and then cooling is to diminish greatly the tenacity and ductility; this is due to a change in crystalline structure, and in order to restore the ductility all that is needed is to subject it to some mechanical process, such as hammering. The results were obtained on commercial zinc wire containing 0·52 per cent. Pb, as it was found impossible to produce wire of pure zinc. By observing the rate of flexure under a force applied to the middle of a bar of pure zinc, it was concluded that the singularity observed in the ductility of wires of commercial zinc in the region of 100° was produced by the admixture of the small proportion of lead. C. O. B.

93. *Cerium-Tin Alloys.* **R. Vogel.** (Zeitschr. Anorg. Chem. 72. 3. pp. 319–328, Oct. 19, 1911.)—Cerium combines with tin with great violence, the temperature rising to 1600° C. momentarily when Ce is dropped into molten tin. It is so active that the usual protectors against oxidation could not be used, and the method used in making the alloys was to drop the Ce—which contained 98·48 per cent. Ce; Fe, La, and Di being the impurities—into the molten tin contained in a red-hot carbon tube. The thermal equilibrium diagram shows that the metals form three compounds, Ce_2Sn, Ce_2Sn_3, and $CeSn_3$, corresponding to maxima at 1400° C., 1165° C., and 1135° C. respectively. Microscopic analysis confirms the existence of these three compounds. All the alloys containing below 80 per cent. Sn are pyrophoric and spark when scratched with a hard object. This is due to a strong affinity for oxygen and great hardness, which attains a maximum of 6 (Moh's scale) in the case of the compound Ce_2Sn. The alloys are unstable in the atmosphere, and decompose water with the evolution of an evil-smelling gas consisting mostly of hydrogen. F. C. A. H. L.

94. *Mechanical and Chemical Properties of Specifically Light Aluminium-Cobalt Alloys.* **H. Schirmeister.** (Metallurgie, 8. pp. 650–655, Oct. 22, 1911.)—Tests made on sand castings indicate that the alloys containing 9–12 per cent. Co possess the best mechanical properties, which are, however, little better than those of Al. The addition of W improves the alloys. Chill castings containing 8–12 per cent. Co and 0·8 to 1·2 per cent. W are about two or three times as strong as Al cast under similar conditions. The low-Co alloys work better but are not so strong as the 12 per cent. alloys. Molybdenum acts in the same direction as W, and does not possess any advantage. None of the alloys resist the action of dilute nitric acid so well as pure Al, but are more stable in air. The Co alloy containing W has a specific gravity of 2·8 to 2·9, but does not appear to be much improved by working. It is recommended that the materials used in preparing the alloys should be as pure as possible and specially free from carbon and sulphur. The pure oxides should be added to molten Al, or better still, the alloys should be prepared by Goldschmidt's method; the fusion of the metals as such cannot be recommended. F. C. A. H. L.

95. *Aerial Oxidation (Rusting) of Metals.* **W. R. Dunstan and J. R. Hill.** (Chem. Soc., Journ. 99. pp. 1835–1853, Oct., 1911.)—The view that CO_2 is not essential to rusting [Abstract No. 193 (1906)] has been confirmed by W. A. Tilden [Abstract No. 1868 (1908)], and the assumption of the intermediate formation of H_2O_2 as a working hypothesis has also been supported. The non-rusting of chemically pure iron in the presence of chemically pure water and oxygen [Abstract No. 554 (1911)] is held not to support the electrolytic theory, to which there are many other objections discussed by the authors. Tests have been made on the action of various inhibiting agents, many of which should, according to the electrolytic theory, assist corrosion by acting as depolarisers. All inhibitors render iron passive in which state iron cannot rust, but the passive state is easily destroyed, *e.g.*, by the action of dilute acids, after which rusting does take place. The aerial oxidation of metals such as Zn, Cu, Al, and Mg is inhibited by the same reagents which induce passivity in iron so that the mechanism of the process cannot be materially different. By the use of a reagent consisting of potassium ferricyanide and ferric chloride the presence of H_2O_2 has been detected during rusting, but at the same time rusting occurs in the presence of such reagents

as potassium iodide, which destroy H_2O_2. It would appear therefore that this compound is a secondary product, and that aerial oxidation is really due to the direct action of oxygen dissolved in water. The action of CO_2 is quite independent of the main process of rusting. F. C. A. H. L.

96. *Cementation of Iron by Solid Carbon.* **G. Charpy and S. Bonnerot.** (Comptes Rendus, 153. pp. 671–673, Oct. 9, 1911.)—Since the work of F. Weyl [Abstract No. 1548 (1910)] leads to different conclusions from the earlier investigations of the authors, who found that solid carbon does not cement iron *in vacuo*, a further series of experiments has been carried out. Carefully purified graphite was compressed under 3000 atmos. between pieces of extra-soft Martin steel to ensure intimate contact. In spite of preliminary heating under reduced pressure it was impossible to eliminate gases, but by carefully working the pump it was possible to keep the pressure between the limits determined upon for a long time. The results of heating six samples to 950° C. for periods varying from 10 to 38 hours show that no cementation is obtained if the pressure be kept at 0·10 mm. (0·1 to 0·3), but if the pressure be allowed to rise above 0·5 mm. a distinct carbonisation takes place. The authors conclude that carbon will not act on iron at temperatures about 950° C. if every precaution be taken to preclude gases liable to act on carbon and iron. F. C. A. H. L.

97. *Properties of Binary Mixtures of some Liquefied Gases.* **L. S. Bagster.** (Chem. Soc., Journ. 99. pp. 1218–1223, June, 1911.)—The author has determined the freezing-point curves of mixtures of hydrogen bromide and sulphide, and of hydrogen iodide and sulphide. The data are as follows:—

$HBr—H_2S$

Mol. per cent. HBr	f.p.	Mol. per cent. HBr	f.p.	Mol. per cent. HBr	f.p.
35·0	—87·0	44·2	—87·0°	55·5	—86·7
39·8	—87·0	49·0	—87·0°	100·0	—83·0
		52·5	—86·9°		

$HI—H_2S$

Mol. per cent. HI	f.p.	Mol. per cent. HI	f.p.	Mol. per cent. HI	f.p.
0·0	—82·0	28·4	—90·8	56·0	—83·0
11·3	—87·0	35·6	—90·7	71·8	—70·0
20·3	—89·0	41·0	—89·0	100·0	—46·0
		51·0	—87·0		

A. F.

98. *The Purification and Properties of Acetic Acid.* **W. R. Bousfield and T. M. Lowry.** (Chem. Soc., Journ. 99. pp. 1432–1441, July, 1911.)—The usual methods of purifying acetic acid have been shown by the authors to yield an acid of doubtful purity, as was indicated by measurements of electrical conductivity. A quantity of acid was then purified by (1) fractional distillation, which yielded a residue consisting of the higher fatty acids; (2) freezing and pouring off the still liquid portions; and (3) oxidation and distillation with potassium permanganate. The carefully purified acid was then used for the determination of certain constants. The melting-point was found to be 16·60° ± 0·005°. The boiling-point was found to be 118·11° ± 0·02° at 766 mm., or 117·88° ± 0·05° at 760 mm. Determinations of the density

gave $d\,18^\circ/4^\circ = 1{\cdot}05148$ and $d\,20/4 = 1{\cdot}04922$. The max. conductivity of acetic acid was then determined and found to be $k_{18} = 0{\cdot}001641_5 + 0{\cdot}0000298\,(t-18)$.
F. J. B.

99. *Formation of Rust.* **G. Bresch.** (Rev. de Métallurgie, 7. pp. 438–446, 1910. Metallurgie, 8. pp. 590–591, Sept. 22, 1911.)—The author has proved that the amount of rust formed when iron is immersed in a solution, is not proportional to the quantity of dissolved oxygen. Solutions of caustic soda and sodium carbonate of strengths greater than N/10 act as protectors against rusting, whilst sodium chloride and potassium in concentrated solutions act as accelerators. All concentrations of potassium dichromate solutions above N/2000 are good protectors, the action persisting at 100° C. Experiments with the ferroxyl reagent show that rusting tends to commence locally. Cold-hardening increases the rate of corrosion, while quenching and annealing appear to exert little or no effect on the local rusting. Zinc in electrical contact with iron exerts a protective action until the whole of the zinc has disappeared. Copper and Pt exert an accelerating effect and contact with glass causes rapid rusting, probably because of the action of the adherent CO_2. The particles of MnS existent in commercial irons give rise to local corrosion. Experiments upon the effect of the conductivity of the solution on the area protected by zinc and the effect of the electrical resistance of the iron appear to favour the conclusion that the p.d. between the iron and solutions in which it is immersed plays an important rôle in the formation of rust.
F. C. A. H. L.

100. *The Laws of Concentrated Solutions.* II. *Estimation of the Degree of Ionisation at Moderate Concentrations.* **E. W. Washburn.** (Amer. Chem. Soc., Journ. 33. pp. 1461–1478, Sept., 1911.)—The neglect of viscosity may produce an error in the coefficient of ionisation of 7 or 8 per cent. in decinormal solutions and nearly 1 per cent. in concentrations as low as 0·01-N. The correction is given in the form $\Lambda = kf^m$, where m is a constant, not far from unity, depending chiefly on the nature of the ion. This gives for the value of the coefficient of ionisation $\gamma = \Lambda/\Lambda_0(\eta/\eta_0)^m$. The true transference number n_A of the ion A in any solution is given by the expression $n_A = n_{0A}(\eta/\eta_0)^{m_A - m}$, where m_A and m are the fluidity exponents for the ion A and the salt. Values for the fluidity exponent were deduced with the help of the two latter equations and showed a good agreement in the case of KCl but less good for NaCl and LiCl. [Compare Abstracts Nos. 1015 and 1170 (1910).]
T. M. L.

101. *Osmotic Pressure and Conductivity of Aqueous Solutions of Congo-red, and Reversible Membrane Equilibria.* **F. G. Donnan** and **A. B. Harris.** (Chem. Soc., Journ. 99. pp. 1554–1577, Aug., 1911.)—Congo-red gives against pure water an osmotic pressure agreeing approximately with that which would be obtained if it existed in aqueous solution as single undissociated molecules. The values found agree as to order of magnitude with those recorded by Bayliss. The osmotic pressure is lowered by sodium hydroxide and sodium chloride, the fall of pressure increasing with the concentration of these electrolytes. From the results of the conductivity measurements it is concluded that Congo-red exists in aqueous solution very largely as a simple and considerably dissociated salt. On dialysis, both Congo-red and benzopurpurine-4B undergo a peculiar "membrane-hydrolysis," sodium ions

in company with hydroxyl ions diffusing out, and the free acids, acid salts, or some other insoluble phase being gradually aggregated or thrown out of solution inside the dialyser or osmometer. This "membrane-hydrolysis" can be prevented by solutions of alkali hydroxide above a certain definite concentration, the latter varying with the temperature and the concentration of the dye-salt. The gradual fall of osmotic pressure observed with pure water as external liquid is due to the membrane-hydrolysis. A consideration of these results shows that the osmotic pressures do not correspond with an ordinary state of osmotic equilibrium, inasmuch as the otherwise diffusible sodium ions are arrested in their diffusion across the membrane by potential differences, and pass slowly through in company with hydroxyl ions. Sodium chloride distributes itself in unequal concentrations on either side of the parchment paper membrane when Congo-red is present on one side. A reversible ionic equilibrium is produced, the concentration of the sodium chloride at equilibrium being higher on the side of the membrane opposite to that in which the Congo-red is present. T. M. L.

102. *Conductivity and Dissociation of Electrolytes.* **H. H. Hosford** and **H. C. Jones.** (Amer. Chem. Journ. 46. pp. 240–278, Sept., 1911.)—The molecular conductivities of 15 inorganic salts were measured from 0° to 35°, and of 16 inorganic salts from 35° to 65°. The temperature coefficients of conductivity were calculated through these ranges of temperature; the percentage dissociations were also calculated where the data were sufficient. In accordance with the view that the ions are hydrated in aqueous solutions, and that the complexes break down with rise in temperature, thus increasing the conductivity, it was found that substances of large hydrating power have large temperature-coefficients. Hydrolysis was found to be a frequent cause of abnormally great conductivity; it is increased both by dilution and by rise in temperature. Another cause of abnormally rapid increase in conductivity is decrease in polymerisation, *e.g.*, there is evidence that sulphates are polymerised in concentrated solutions. Previous observers have found an increase in the conductivity of a solution of a chromium salt when it is changed from the violet to the green variety. It has now been found that whilst the conductivity of concentrated solutions is increased by this change, the increase is less at higher dilutions and that the conductivity of the green variety may even fall below that of the violet variety. This would appear to show that the green variety is not as susceptible to hydrolysis by dilution as is the normal violet form. The existence of double salts in solutions of alums, inferred from the diminution of conductivity on mixing the constituent sulphates, is confirmed by observations at higher temperatures. T. M. L.

103. *Aluminium Bromide as Solvent.* **B. A. Isbekow** and **W. A. Plotnikow.** (Jurn. Russk. Fisik-Chimičesk. Obščestva, 1911. Zeitschr. Anorg. Chem. 71. 4. pp. 328–346, Aug. 10, 1911.)—The compounds KBr, NaBr, NH_4Br, AgBr, $CaBr_2$ dissolve in $AlBr_3$ at about 100° to form two layers, the upper layer consisting mainly of the "solvent," and the lower layer mostly of the "solute." In the case of NaBr 5 %, the two layers vanish on heating to 230°, and in the case of AgBr 5 %, at 180°, but KBr and NH_4Br give two layers right up to the boiling-point. It is stated that "on the addition of further quantities of salt the concentration of the upper layer increases quickly at the expense of the lower layer, and a homogeneous solution finally results"; this result is difficult to account for in the case of pure materials. A description is also given of the behaviour of the bromides of the heavy metals.

Measurements were made of the conductivity of potassium, mercuric and antimony bromides in fused $AlBr_3$. The $AlBr_3$ has no appreciable conductivity but shows a progressive increase up to 18 per cent. KBr and 80 per cent. $HgBr_2$ at 100°. In the case of antimony bromide a complete series of solutions could be prepared; these showed a max. conductivity at 81% $SbBr_3$; the curve resembles that for a mixture of an acid with water, the $AlBr_3$ corresponding to the acid and the $SbBr_3$ to the water. The "molecular conductivity" of KBr increased with dilution as in aqueous solutions; that of $HgBr_2$ decreased rapidly towards a zero value; that of $SbBr_3$ at first increased, and then decreased almost to zero. The temperature-coefficients were curious; 7·81% $HgBr_2$ showed a max. conductivity at 130°, falling almost to zero at 190°; 14·88 % $HgBr_2$ showed a maximum at 150°; 21·08 % $HgBr_2$ just reached a maximum at 190°. 15·27 % $SbBr_3$ gave a symmetrical curve with a maximum at 140°, falling almost to zero at 190° and 90°, but a 50·85 % mixture showed a linear increase from 100° to 190°, and a similar statement holds good for 18·07 % KBr. Actual electrolyses showed the separation of Sb, Hg, and Al from solutions of $SbBr_3$, $HgBr_2$ and KBr respectively. This series of solutions is of special interest (1) as supplementing existing data in the region of weak electrolytes, and (2) as extending the known properties of solutions to mixtures of fused salts. T. M. L.

104. *Viscosity and Fluidity of Suspensions.* **E. C. Bingham** and **T. C. Durham.** (Amer. Chem. Journ. 46. pp. 278–297, Sept., 1911.)—Measurements were made of the viscosity of suspensions of infusorial earth, clay, and graphite in water, and of infusorial earth in alcohol at temperatures from 25° to 65°, using a viscometer with a long, wide capillary to prevent clogging. It was found that the fluidity decreased according to a linear law as the percentage of solid was increased, and that a zero fluidity would be reached at 18 per cent. of earth in water or 12 per cent. in alcohol, 5¼ per cent. graphite and 4 per cent. clay in water, if the linear law held good throughout. The fluidity and stability are largely affected by small amounts of impurities, especially acids and alkalies, which tend respectively to coagulate and promote suspensions. [This fact is made use of in casting clay in alkaline suspensions which are afterwards coagulated.] T. M. L.

105. *Properties of Salt Solutions in Relation to the Ionic Theory.* II. *Electrical Transference Numbers.* **A. A. Noyes** and **K. G. Falk.** (Amer. Chem. Soc., Journ. 33. pp. 1436–1460, Sept., 1911.)—A critical summary is given of the data in reference to transport-numbers, derived both by the gravimetric method and by the method of moving boundaries, for some sixty salts at concentrations from N to 0·005-N and at temperatures from 0° to 96°. Rise of temperature invariably causes the figure to approach towards 0·5; rise of concentration sometimes produces no effect (*e.g.*, $AgNO_3$ at 30°) but may cause either a decrease ($CaSO_4$) or an increase (HCl) in the relative mobility of the kathion. The values for HCl and H_2SO_4 show marked change of mobility at extreme dilutions, and it is suggested that the values generally accepted for the ionic mobilities at infinite dilution may be in error. [Compare Abstract No. 1787 (1910).] T. M. L.

106. *Application of Kirchhoff's Equations to Solutions.* **R. T. Hardman** and **J. R. Partington.** (Chem. Soc., Journ. 99. pp. 1769–1775, Oct., 1911.)—The solubilities are recorded, over a range of temperatures, of anthraquinone in benzene and in chloroform, of anthracene and of phenanthraquinone in

benzene and of sucrose in water. These could be calculated accurately from the equation $\log s = A - B/T - C \log T$, analogous to the vapour-pressure equation $\log p = A - B/T - C \log T$. T. M. L.

107. *Molecular Condition of Dissolved Substances.* **P. Girard** and **V. Henri.** (Comptes Rendus, 153. pp. 946–948, Nov. 13, 1911.)—The author criticises the conclusions of Colson and of Fouard who conclude from cryoscopic and osmometric observations respectively that substances such as sugar are polymerised in solution and that Arrhenius' theory of electrolytic dissociation is not generally valid. The criticism is directed chiefly to the osmometric methods of Fouard as applied to certain salt solutions which are regarded as unsuitable for experiments with copper-ferrocyanide membranes.

T. M. L.

108. *Syntheses of Hydrocarbons at High Temperatures.* **J. N. Pring** and **D. M. Fairlie.** (Chem. Soc., Journ. 99. pp. 1796–1811, Oct., 1911.)—The experiments of Pring [see Abstract No. 1016 (1910)] have been continued with rods of carbon, 8 cm. long, 4 mm. in diam., purified in chlorine at 1400° C. and by other means, sometimes galvanically coated with Pt or Pd, or chemically with Si (from H and $SiCl_4$ at 1700° C.). The carbon is electrically heated in an atmosphere of hydrogen, and the resulting gases are circulated through charcoal cooled in liquid air. At 1200° C. and pressures from 10 to 60 cm. methane and ethylene are formed, the rate of formation of the latter being 0·01 of that of methane; acetylene is not formed at that temperature, and the rate of circulation was such that the methane could hardly result from the interaction of hydrogen with any initially formed ethylene. At higher temperatures the ratio of ethylene and methane formed increases, to 1:10 at 1400°. At 1650° methane, ethylene, and acetylene are formed, twice as much ethylene as acetylene. Both Pb and Pd assist these syntheses catalytically, Si does not. On the suggestion of R. E. Slade the carbon rod was provided with a sleeve of Pt-gauze, 2 cm. in diam., charged to 400 volts (+ or −); the ionisation of the gases by the electric field made no appreciable difference in the rate of the methane production between 1200° and 1650° C.

H. B.

109. *Decomposition of Dry Ozone.* **D. L. Chapman** and **H. E. Jones.** (Chem. Soc., Journ. 99. pp. 1811–1819, Oct., 1911.)—According to Shenstone (1897) dry ozone is too unstable to be prepared from pure oxygen by the silent discharge, and the stability of moist ozone decreases as the moisture is removed. H. E. Armstrong attributed the instability to the presence of nitrogen oxides, which were more readily formed when the gas was dry. This latter assumption (dryness favourable to the oxide formation) is confirmed. But ozone desiccated in a novel way by long exposure to phosphoric oxide (especially prepared) and ozone dried by contact with concentrated sulphuric acid decompose at the same rate. It would follow from these and other experiments that ozone can revert to oxygen without the intervention of any other substance. Yet water is not a weak catalyst for the decomposition of ozone. Ozone passed into strong caustic alkali furnishes a yellow-brown solution, apparently salts of a weak acid H_2O, nO_3 which seems to ionise and to change into water and oxygen. H. B.

110. *Formation of Oxygenated Water by the Brush Discharge.* **A. Besson.** (Comptes Rendus, 153. pp. 877–879, Nov. 6, 1911.)—Oxygenated rain, *i.e.*,

rain containing H_2O_2, is sometimes observed, especially in summer with heavy drops from a previously clear sky. The author finds that water-vapour alone never gives the CrO_3 reaction for H_2O_2 (though generally the iodine starch reaction, probably because some ozone is formed), when the discharge (this part of the apparatus is not described) acts on the cold air at pressures between 760 and 80 mm. In the presence of oxygen H_2O_2 is formed, as long as the pressure is not reduced below half atmospheric pressure. When air was admitted, the phenomena became more uncertain. Yet the author believes that the H_2O_2 in rain is due rather to electric phenomena than to ultra-violet radiations. H. B.

111. *A Case of an Electrolytic Saturation Current.* **G. Jaffé.** (Ann. d. Physik, 36. 1. pp. 25–48, Oct. 3, 1911.)—It has been shown by the author and others that badly conducting liquids, for example, hexane, behave similarly to gases in that they give a saturation current. It was, therefore, of interest to find an example of the occurrence of a saturation current in a solution showing only a small electrolytic conductivity, and the author has succeeded in doing this in the case of solutions of lead oleate in hexane and in light petroleum. When the compounds used have been carefully purified the relation between the current strength, i, and the voltage, e, is given by the equation: $i = f(e) + ce$. The first term represents the saturation portion of the current and remains constant above a certain value of the strength of the field, which lies between 500 and 1000 volts per cm. The second, very small term, represents that portion of the current which follows Ohm's law, even for the highest voltages used, and is probably due to slight impurities in the salt used. It was also possible to measure separately the velocity of formation and of reunion of the ions; both reactions are dimolecular, so that the degree of dissociation of the electrolyte is independent of the concentration. The velocity of formation of the ions depends on the temperature and apparently is a minimum at room temperature. The addition of ethyl alcohol to pure hexane causes a very rapid increase in the conductivity. [See Abstracts Nos. 898 (1905), 938 (1909), 964 (1910).]

T. S. P.

112. *Electrolytic Corrosion of some Metals in Salt Solutions.* **G. R. White.** (Journ. Phys. Chem. 15. pp. 723–792, Nov., 1911.)—A detailed account of the electrolytic dissolution of anodes of Zn, Cu, Sn, Cd, Fe, Ni in solutions of sodium acetate, chloride, sulphate, nitrate, tartrate, at concentrations of 75 and 25 gm. per litre, generally at ordinary temperature. The electrodes were filed, rubbed with carborundum paper, and washed after each experiment; even then exact duplication of the results was difficult. When the corrosion was less than the theoretical, some protective film (oxide or hydroxide) could generally be observed; when the corrosion was too great, the electrolyte had sometimes attacked the metal chemically, or complex compounds had formed into which the metal entered with lower valency (Cu, also monovalent Sn and Cd). In nitrate some nitrite was formed, but this did not account for the excessive corrosion. Copper turned passive in tartrate. The concentration had little influence; increased current density might increase or decrease the corrosion. H. B.

113. *Electrolytic Corrosion of Iron by Direct Current.* **J. L. R. Hayden.** (Frank. Inst., Journ. 172. pp. 295–308, Oct., 1911. Electrician, 68. pp. 470–471,

Dec. 29, 1911. Abstract.)—If an aqueous solution is electrolysed, using an iron anode, the corrosion of the anode, as measured by the loss in weight, is not necessarily determined by the amount of current passed, since the iron may be either in the passive state, when no corrosion takes place, or in the active state, when the corrosion is in accordance with Faraday's laws. The author could not determine, with certainty, the factors determining the state of the anode, since in some cases both states were observed when the conditions of experiment were apparently identical. It was shown, however, that the passive state is caused by alkalinity of the electrolyte, and by the presence of nitrates or dichromates, the attainment of the passive state being characterised by the formation of ferric salts and by the setting-up of a higher potential in the cell. On the other hand, chlorides and sulphates make the anode active, ferrous salts being then formed. A high current-density, even if only momentary, favours the formation of the passive state, whilst absence of current favours the active state. By comparative experiments it was found necessary to add more ammonium chloride to a dichromate than to a nitrate solution in order to do away with the passive state; sulphates more readily produce the active state of electrolytic corrosion than do chlorides.
T. S. P.

114. *Passivity of Iron and Certain Other Metals.* **W. R. Dunstan** and **J. R. Hill.** (Chem. Soc., Journ. 99. pp. 1858–1866, Oct., 1911.)—From time to time various theories have been put forward to explain the passive state, none of which, however, are completely satisfactory [see Abstracts Nos. 2288 (1900), 1727 (1908), and 1647 (1909)]. Experiments made by the authors show that air plays no part in rendering iron passive, which state is destroyed by vigorous shaking and dilute acids, but not by reducing agents in solution. The addition of salt to dichromate solution hastens corrosion, which phenomenon has been traced to the combined effect of air and electrolytic effects. Passivity is not destroyed by heating to 400° C. *in vacuo* or in nitrogen, but hydrogen destroys the state at 250° C., at which temperature magnetic oxide of iron is reduced. Zinc, Cu, and Mg are all rendered passive by potassium dichromate; but the state is partially destroyed by heating. The authors consider these facts as strong evidence in favour of the oxide-film theory, which does not, however, account for the passivity induced by caustic alkalies.
F. C. A. H. L.

115. *Photography of Electrolytic Deposits.* **B. Wäser** and **R. Kühnel.** (Elektrochem. Zeitschr. 18. pp. 211–215, Nov., 1911.)—The continued researches [see Abstract No. 1635 (1911)] concern the deposition of copper from neutral and acid sulphate, Oettel's solution, and acid sulphate solution containing some NaCl. In the last-mentioned case the anode turns white because cupro-chloride is formed (Wohlwill). Acid sulphate gives hardly any metallic deposit at 100° C., as Foerster and Seidel had observed, but a white precipitate of cupro salt is formed. As in the case of lead deposits, a boundary between the copper kathode and the deposit could not be observed.
H. B.

116. *Electrolytic Reduction of Ketones.* **J. Tafel** and **W. Schepss.** (Zeitschr. Elektrochem. 17. pp. 972–976, Nov. 15, 1911.)—Tafel had observed that isoamylmethyl ketone was more readily reduced to isoheptane at Cd-kathodes than at Pb-kathodes. The Cd-kathodes, F. Bauer and later W. Schepss find, are in general preferable for ketone reduction, and acetone

is almost completely reduced to propane, while kathodes of Pb and Hg give a less complete reduction. Isopropyl alcohol is not attacked under the conditions of the acetone reduction in solutions of sulphuric acid. H. B.

117. *Rapid Electro-analysis with Stirring by Blowing Gases through the Electrolyte.* **F. Fischer, C. Thiele,** and **E. Stecher.** (Zeitschr. Elektrochem. 17. pp. 905–906, Oct. 15, 1911.)—The apparatus used by the authors consists of a large boiling-tube with three indentations towards the bottom, on which the cylindrical wire-gauze kathode rests. Down the centre of the tube passes a narrow glass tube with a bulb, perforated with several holes at the lower end; the anode of Pt wire forms a spiral round this tube. Hydrogen is forced through this tube during the analysis, the escaping bubbles stirring the electrolyte. The mouth of the boiling-tube is fitted with a small funnel to prevent loss of liquid. The hydrogen is forced in at such a rate that the electrolyte wells up about 5 cm. above its normal level; if the electrolysis is conducted at about 60° C., water-vapour condenses on the upper part of the boiling-tube, and washes it down completely. 0·1817 gm. of copper was quantitatively deposited from an acid copper sulphate solution in 8–12 min., using 1·2 amps; 0·1857 gm. of Ni was quantitatively deposited from an ammoniacal solution in 10 min. under the same conditions. T. S. P.

118. *Rapid Electro-analysis under Diminished Pressure.* **F. Fischer, C. Thiele,** and **E. Stecher.** (Zeitschr. Elektrochem. 17. pp. 906–908, Oct. 15, 1911.)—The apparatus is of a form similar to that described in the preceding Abstract. The kathode rests, however, at the bottom of the boiling-tube and the anode is sealed into a glass tube, filled with mercury, which passes through a rubber bung closing the mouth of the boiling-tube. Through this bung also pass a tube (A) connecting with a pump for diminishing the pressure and a right-angled tube fitted with rubber tubing and a screw clip. This latter tube is closed during the electrolysis; but when all the metal has been deposited it is connected with a flask of distilled water, and the tube A pushed down to the bottom of the boiling-tube, so that the electrolyte can be displaced by distilled water before cutting off the current. The advantage of diminishing the pressure is that the gas bubbles escaping from the electrodes are much larger and the liquid boils at a lower temperature, so that the stirring is very complete. 0·1817 gm. of copper was quantitatively deposited from a sulphuric acid solution in 9–15 min. at 70°, using 8–2 amps. T. S. P.

119. *The "Peeling-off" of Electrolytic Nickel.* **K. Engemann.** (Zeitschr. Elektrochem. 17. pp. 910–917, Oct. 15, 1911. Extract from Dissertation, Dresden, 1911.)—When iron is present in a nickel solution it is deposited more readily than the Ni; the first deposits on the electrode are richer in iron than the succeeding ones. It is this variation in the iron-content of the layers which causes Ni deposited from a sulphate or chloride electrolyte to peel off. Peeling does not take place when Ni is deposited from a neutral or weakly acid solution in the absence of iron. The hardness of electrolytic Ni is little affected by the nature of the salt used, whether sulphate or chloride; it increases, other things being equal, with the acidity of the solution, and is diminished by the addition of sodium salts to the electrolyte. The flexibility of Ni deposited from sulphate solution is greater than that of Ni from a chloride electrolyte, and is increased by the addition of sodium salts. T. S. P.

120. *Thermodynamics of Concentration Cells.* **H. S. Carhart.** (Bureau of Standards, Bull. 7. pp. 475–494, Oct., 1911.)—The general thermodynamic expression for an isothermal process may be written $A = H + T \cdot dA/dT$, where H denotes the change in the internal energy of the system, and A the max. work or the change of free energy for a reversible physical or chemical process conducted isothermally. When applied to concentration cells this becomes, in the form of the Helmholtz equation, $E = H/nF + T \cdot dE/dT$. From these equations it follows: (1) When H has a constant or a zero value, dA/dT or dE/dT is constant, and $A = H + aT$ where a is an integration constant. (2) When $A = 0$, $H = -T \cdot dA/dT$. This condition is found in the case that A passes through a zero value at some definite temperature, *e.g.*, transition-point. (3) In his recent modification of the thermodynamic expression Nernst assumed, without sufficient justification, according to the author, that both dA/dT and dH/dT are zero when T is zero. The author points out, however, that $dA/dT = a$ when $T = 0$; hence in Nernst's expansion for A, viz., $A = A_0 + aT + bT^2 + \ldots$, the term aT is not zero, as Nernst has put it. If it were zero, the expression for A would exclude the case of concentration cells in which A is proportional to the absolute temperature (for very dilute solutions), or is equal to a constant H plus a term proportional to the first power of the absolute temperature. Such concentration cells are in fact found in the case of zinc amalgams and either zinc sulphate or zinc chloride solutions, and of cadmium amalgams and cadmium sulphate solution. In these the e.m.f. is a linear function of the temperature—a fact contrary to Nernst's hypothesis. For these cells, moreover, as well as for others investigated by Richards, dE/dT is a constant for each combination. H is therefore also constant. The author also shows that the electrolytic thermo-e.m.f. for zinc amalgams in contact with a solution of a salt of zinc is proportional to the temperature. In this instance, so long as there is no change of phase H is zero, and $E = aT$. When H is known for any two amalgams, the e.m.f. of the corresponding concentration cell may be calculated from H and the two thermo-electromotive forces. By opposing the value of dE/dT for the amalgams by an equal and opposite value of dE/dT arising from a difference in the concentration of the electrolyte at the two electrodes it is possible to make a concentration cell independent of the temperature. Its e.m.f. is derived entirely from the heat of dilution of the amalgams and of the electrolytes. The value of dE/dT for the calomel cell is positive, and is shown to be dependent on the difference between the thermo-e.m.f.'s at the two electrodes. By taking advantage of the fact that electrolytic thermo-e.m.f.'s vary with the concentration of the amalgams, it is found possible to make a calomel cell with a negative temperature-coefficient numerically equal to that of the normal calomel cell, so that when the two are connected in series their combined e.m.f. is practically constant and independent of temperature over a range of 25 or 30 degrees. A. F.

121. *Influence of the Magnetic Field on Passive Nickel and Iron.* **H. G. Byers** and **A. F. Morgan.** (Amer. Chem. Soc., Journ. 33. pp. 1757–1762, Nov., 1911.)—The current density required to render Ni passive is materially increased when in the magnetic field, as has been previously shown to be the case with iron [see Abstract No. 1375 (1910)]. Steel when magnetised is more difficult to render passive than is the same steel unmagnetised, and soft steel is affected to a greater extent than hard steel. The positive pole of the magnets is more easily rendered passive than is the negative pole.

T. S. P.

SCIENCE ABSTRACTS.

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